OCTOBER 1959

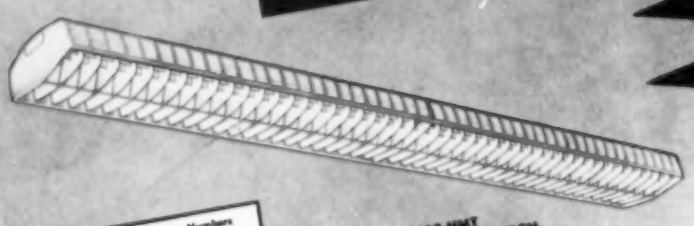
ie

ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY

Information You Can Use

PACEMAKER®
WITH ILLUMINATED STEEL SIDES



PMR-218-HMT
4-F40T12/RS TANDEM

PACEMAKER—Catalog Numbers

	Catalog Number	No. of Lamps
35° Cross x 25° Longitudinal Shielding		
4 ft. R. S.	PMR-214-M	2-F40T12/RS
8 ft. R. S.	PMR-218-SM	4-F40T12/RS
4 ft. Slm.	PMS-214-M	2-F48T12
8 ft. Slm.	PMS-218-M	2-F96T12
35° Cross x 45° Longitudinal Shielding		
4 ft. R. S.	PMR-214-MT	2-F40T12/RS
8 ft. R. S.	PMR-218-TMT	4-F40T12/RS
4 ft. Slm.	PMS-214-MT	2-F48T12
8 ft. Slm.	PMS-218-MT	2-F96T12
45° Cross x 45° Longitudinal Shielding		
4 ft. R. S.	PMR-214-MM	2-F40T12/RS
8 ft. R. S.	PMR-218-MMT	4-F40T12/RS
4 ft. Slm.	PMS-214-MM	2-F48T12
8 ft. Slm.	PMS-218-MM	2-F96T12

STANDARD FINISH: All white baked enamel. White and low brightness aluminum variations also available.

The Pacemaker is formed 20 gauge steel. The steel sides are slotted to illuminate the visible surface. Finish is undercoated for corrosion protection and sprayed white enamel of .88 reflectance. Important reflecting surfaces face downward for minimum dirt collection.

The ballasts are UL/CSA, ETL, CBM listed. Units carry the IBEW label.

LIMITATIONS: On close ceiling mounting be sure to specify the #41-B mounting assembly.

SPECIFYING POINTS FOR ARCHITECTS AND ENGINEERS: Body and sides are 20 gauge steel. Sides slotted to provide illuminated side panel. All reflecting surfaces face downward for minimum dirt collection.

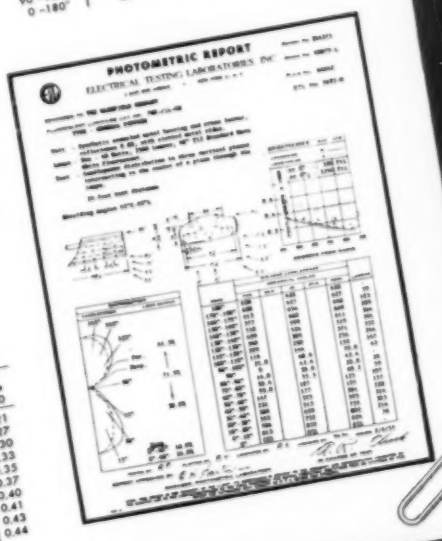
PHOTOMETRIC: This line of luminaires shall be a general diffusing type in accordance with an Electrical Testing Laboratory report.

The distribution of light flux shall be as follows:

Cone	35° x 25°	35° x 45°	45° x 45°
0 –40°	23.0	20.5	18.0
0 –60°	36.5	31.0	26.0
0 –90°	42.5	36.5	30.0
90°–180°	40.5	40.0	41.5
0 –180°	83.0	76.5	71.5

COEFFICIENTS OF UTILIZATION
For PMR.214 With 25° x 35° Shielding

Room Index	Ceiling Reflectance 75			Ceiling Reflectance 50			Ceiling Reflectance 30	
	Wall Reflectance			Wall Reflectance			Wall Reflectance	
	.50	.30	.10	.50	.30	.10	.30	.10
J 0.6	0.31	0.27	0.25	0.27	0.25	0.23	0.23	0.21
I 0.8	0.37	0.34	0.32	0.33	0.31	0.29	0.28	0.27
H 1.0	0.41	0.38	0.36	0.36	0.34	0.33	0.32	0.30
G 1.25	0.45	0.42	0.40	0.40	0.37	0.36	0.34	0.33
F 1.5	0.48	0.45	0.42	0.42	0.40	0.38	0.36	0.35
E 2.0	0.51	0.49	0.46	0.46	0.43	0.41	0.39	0.37
D 2.5	0.56	0.52	0.49	0.50	0.46	0.44	0.41	0.40
C 3.0	0.58	0.55	0.51	0.52	0.48	0.46	0.44	0.43
B 4.0	0.61	0.57	0.55	0.54	0.50	0.48	0.46	0.44
A 5.0	0.62	0.59	0.57		0.52	0.50		


PHOTOMETRIC REPORT
ELECTRICAL TESTING LABORATORIES, INC.

This is one of several dozen "spec" sheets, printed on both sides, giving concise data on Wakefield's many commercial and industrial lighting units. We'll be glad to send them to you.

WAKEFIELD

THE WAKEFIELD COMPANY—VERMILION, OHIO
WAKEFIELD SOUTHWEST COMPANY — OKLAHOMA CITY, OKLA.
WAKEFIELD LIGHTING LIMITED — LONDON, ONTARIO

Not a worry in the world of fluorescent lighting with the new Advance fluorescent lamp ballast service warranty program

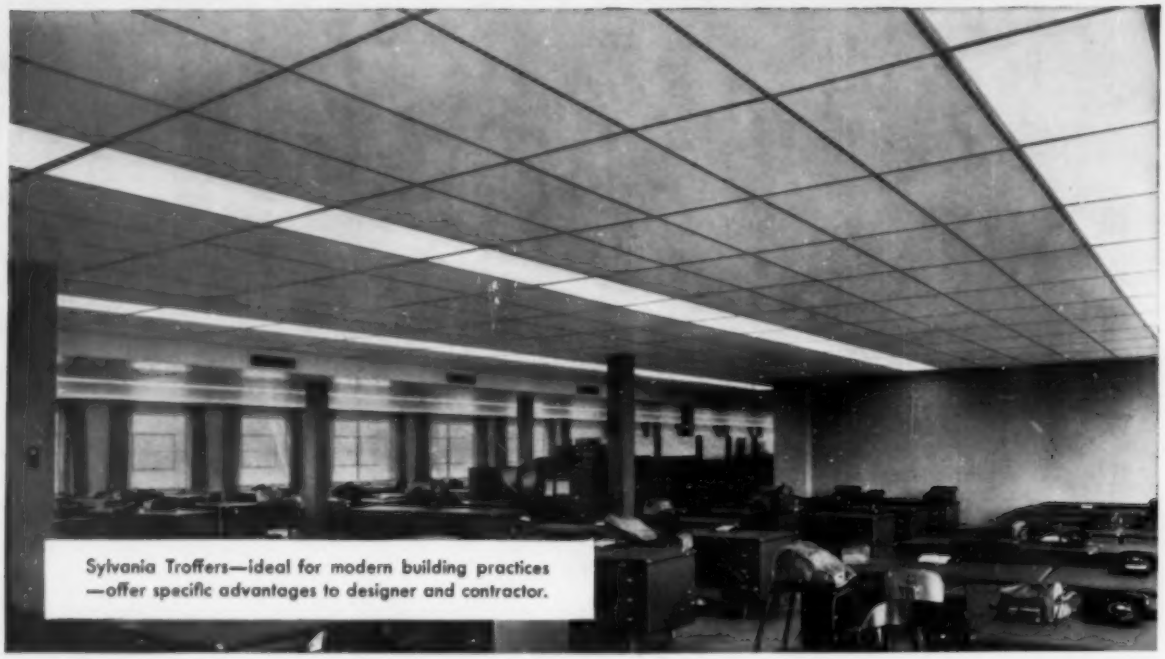
ADVANCE FLUORESCENT LAMP BALLAST
SERVICE WARRANTY POLICY

This new ADVANCE Fluorescent Lamp Ballast Service Warranty Program has been designed to protect every fluorescent lighting equipment manufacturer, specifier, supplier, installer and fluorescent lighting user against labor costs arising from an excessive number of failures directly attributed to self-contained components within an ADVANCE Fluorescent Lamp Ballast. Contact your ADVANCE Representative or write for details on this amazing new protection plan.

ADVANCE TRANSFORMER CO.

RECESSED TROFFERS BY SYLVANIA

...designed for the man who *works with lighting!*



Sylvania Troffers—ideal for modern building practices —offer specific advantages to designer and contractor.

Sylvania's new line of Recessed Troffers has received exceptional acceptance from men who know and work with lighting . . . and for good reasons.

These Troffers give the smart trim appearance and good lighting qualities that guarantee user satisfaction. In addition, they have important *built-in features* which are not apparent to this user—but *which are vital to the designer and contractor responsible for the specification and installation of the lighting equipment.*

FOR THE DESIGNER—Shallow Sylvania Troffers combine smooth, uncluttered finished appearance with practically limitless application possibilities.

The use of hidden latches and hinges and the extensive choice of shielding media bring the designer's ideas to attractive reality in the finished installation.

3 types of fixture housing—with exposed, concealed or fit-in flanges—permit Sylvania Troffers to fit ALL popular ceilings.

And Sylvania Troffers achieve any desired lighting layout because of the wide choice of standard elements including 1′ and 2′ wide models, downlighting Accent Units and 4′ x 4′ units.

FOR THE ELECTRICAL CONTRACTOR

Sylvania Troffers supply labor saving, time saving advantages so necessary for profitable operation. For instance—Sylvania's exclusive Snap-Up Hanger eliminates the need of hanger straps for many ceiling types and reduces installation time appreciably . . . and the adjusting screw of this Snap-Up Hanger levels the Troffer simply and quickly through the use of a screwdriver from below.

Wasted time and motion on the job are eliminated through Sylvania's use of maximum factory pre-assembly and unit packing. Fixtures are normally shipped in individual cartons with end caps and accessories in place and with shield frame and shielding installed.

The next time you specify or install recessed lighting, check the many advantages of Sylvania Troffers before making your choice. Compare Sylvania Troffers feature for feature with other makes. Then you be the judge.

For complete information, write to:

SYLVANIA LIGHTING PRODUCTS
A Division of SYLVANIA ELECTRIC PRODUCTS INC.
Department S-59-10
One 48th Street, Wheeling, West Virginia

GO MODERN WITH LIGHTING BY **SYLVANIA**

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

FLUORESCENT LIGHTING FIXTURES AND SYSTEMS • BEST FIXTURE VALUE IN EVERY PRICE RANGE

ie

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

October 1959

Vol. LIV, No. 10

1959-1960 Officers

President
Joseph B. Browder

Vice-President
Richard G. Slauer

Vice-President
James R. Chambers

General Secretary
G. Franklin Dean

Treasurer
W. P. Lowell, Jr.

•

Editor
Ruby Redford

•

Advertising Manager
Clayton E. Ellis

•

Assistants
Barbara E. Marwell, Editorial
Adelaide Philiba, Advertising

•

Publications Committee
R. M. Zabel, Chairman
R. W. Morris, Vice-Chairman
Charles L. Amick
Brooks Chassaing
Floyd W. Sell
Nelson Warner

•

Managing Director
A. D. Hinckley

Technical Director
C. L. Crouch

Contents

613 Joseph B. Browder, IES President, 1959-1960

615 Integrated Lighting-Air Conditioning Systems—W. S. Fisher and J. E. Flynn

625 Cathedral of St. Louis

627 Designing Low Brightness Luminaires for Higher Lighting Levels—O. D. Dobras and D. R. Phillips

634 Custom-Made Lighting for Customer Appeal

636 Application Possibilities of Wide Range Dimming of Fluorescent Lamps—Philip E. Massie and Allen B. Rosenstein

640 Assessment of Color Rendition Under an Illuminant Using Color Tolerances for Natural Objects—C. L. Sanders

647 How to Improve Ballast Testing—W. W. Brooks

651 Lighting for Low-Ceiling Classrooms

655 IES Guide for Photometric Measurements of Mercury Lamps

658 IES Officers and Council, 1959-1960

660 IES Section and Chapter Chairmen, 1959-1960

7A Lighting News

19A Listing of IES National and Local Officers, 1959-1960

25A IES Committee Personnel, 1959-1960

37A IES Publications

51A Index to Advertisers

53A *IES Lighting Handbook*, Third Edition

Sustaining Members—Refer to September 1959 ILLUMINATING ENGINEERING

STATEMENTS and opinions in articles and papers in ILLUMINATING ENGINEERING are the expressions of contributors and do not necessarily represent the policies or opinions of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council of the Illuminating Engineering Society.

ILLUMINATING ENGINEERING SOCIETY

EDITORIAL and advertising offices
1860 Broadway, New York 23, N. Y.

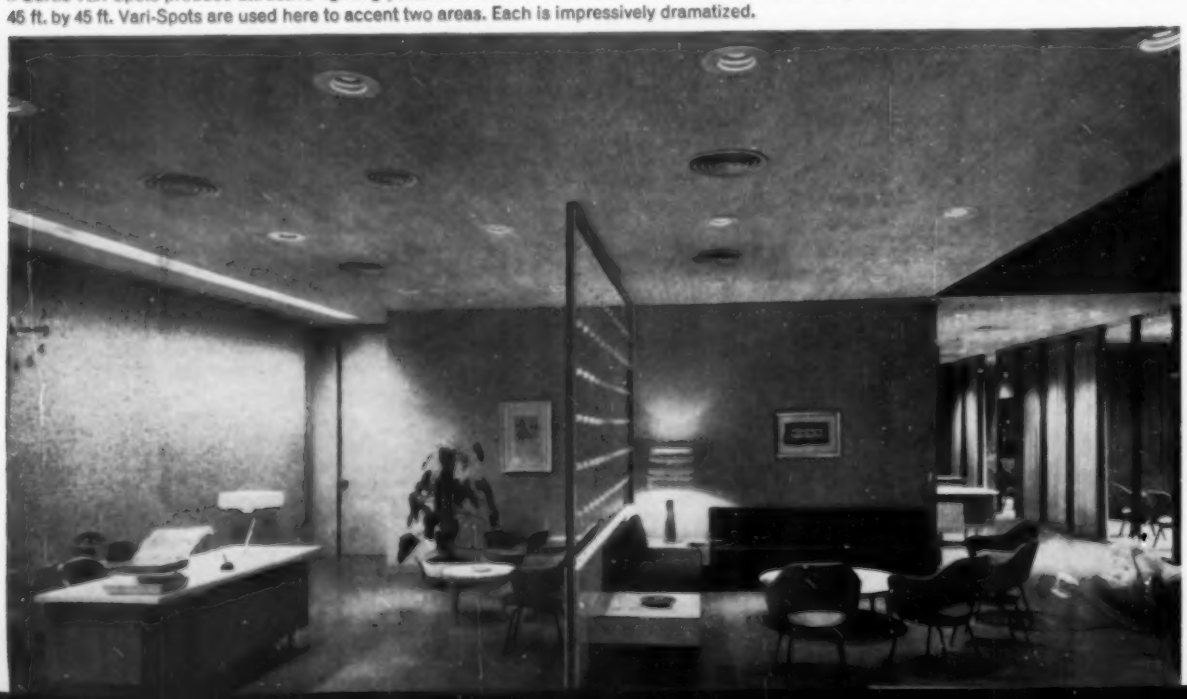
PUBLICATION office 32d Street & Elm Avenue, Baltimore 11, Md.

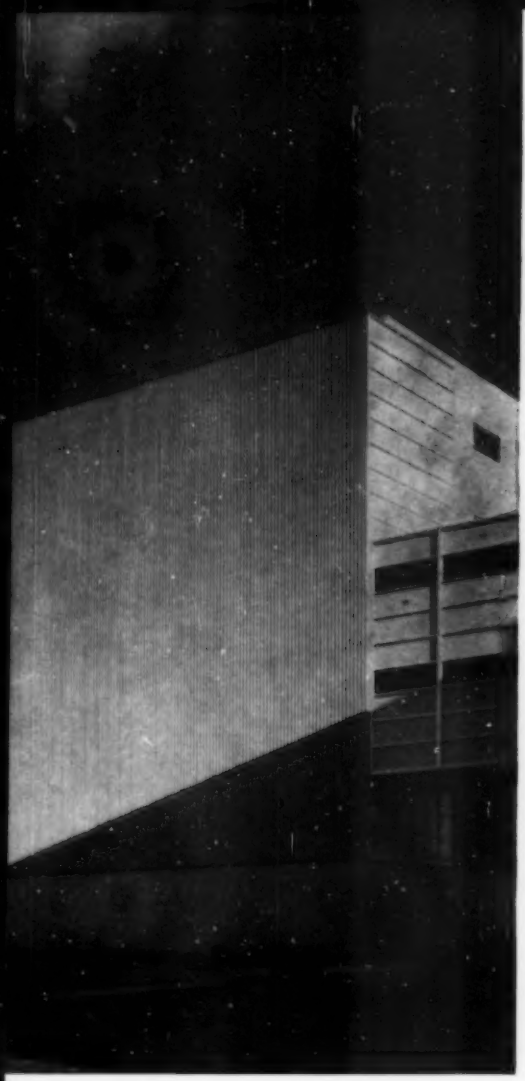
Founded 1906

ILLUMINATING ENGINEERING: The Journal of the Illuminating Engineering Society. Copyright 1959 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. ¶ Subscription $18 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. ¶ Address changes must be received at I.E.S. headquarters by the first of the month to be effective with the issue of the next succeeding month.

■ Hallmark Cards, Kansas City, Mo., where Curtis Visioneers "personalized" the illumination system in keeping with the products of the company. Architect & Consulting Engineer: Welton Becket.

■ Curtis Vari-Spots produce attractive lighting patterns in several lobbies of the Hallmark Cards building. Reception room shown is approximately 45 ft. by 45 ft. Vari-Spots are used here to accent two areas. Each is impressively dramatized.





■ General office. Curtis Alzak aluminum low-brightness troffers assure glare-free illumination throughout the area, combining visual well-being with visual charm.

Curtis Lighting helps Hallmark Cards say "Welcome!"

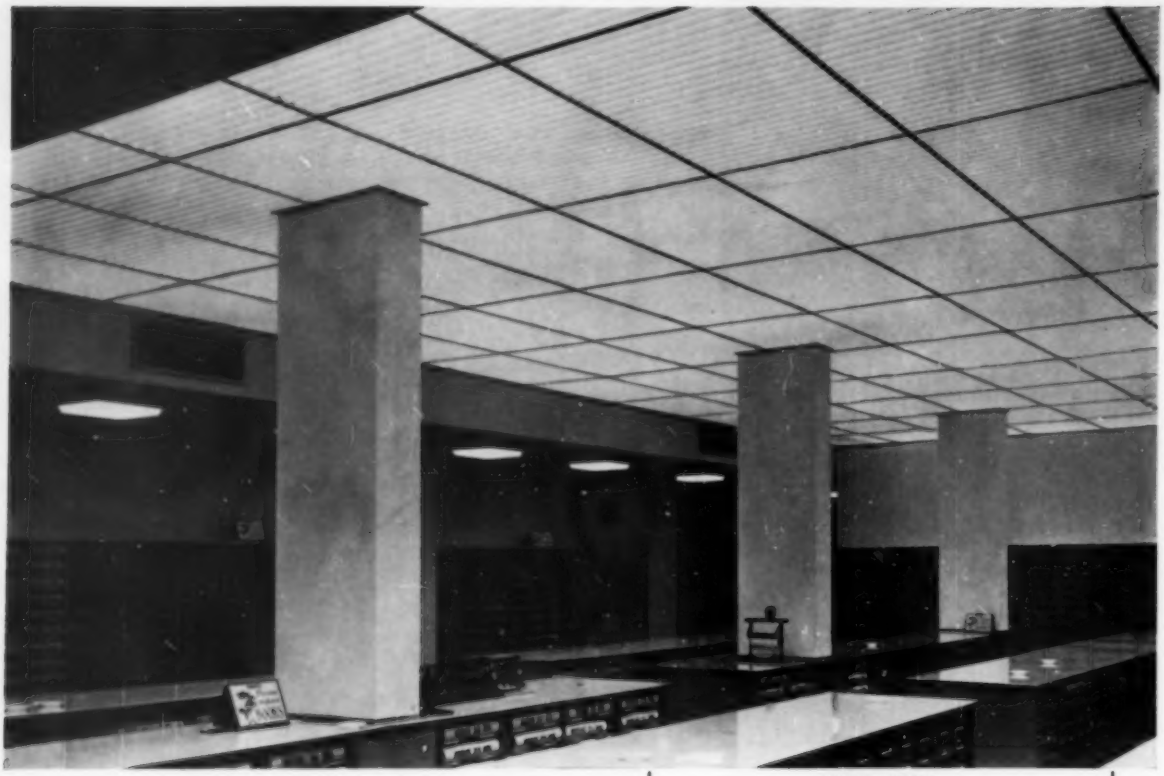
Special illumination effects in greeting card building . . . accent high visual comfort . . . create a feeling of friendliness

It's only natural that a greeting card company would want to capture the spirit of its product in its headquarters building. And that was done at Hallmark Cards, Kansas City, Missouri. Technically, the lighting problem called for a system that would be uniform throughout the structure, yet provide the same glare-free illumination in rooms of various sizes. The assignment clearly prescribed Curtis Visioneering. The desired result was effected when Curtis designed a lighting system combining Curtis Alzak aluminum low-brightness troffers and Curtis Vari-Spot recessed incandescent units. The careful application of Curtis products completed the theme of visual charm and warm greeting, thus accentuating the aesthetic characteristics of the Hallmark Cards building. For assistance on your lighting problems write for the name of the Curtis Visioneer nearest you. Curtis-AllBrite Lighting, Inc., 6135 W. 65th Street, Chicago—352 Shaw Road, South San Francisco.

CURTIS

visioneers in planned lighting

All-Brite



Glare-Controlled
LITECONTROL Lighting
Does a Good Deed in this Courthouse Document Room

Deeds and other documents (some of them yellowing with age) are now easier to read in York, Pennsylvania, thanks to Litecontrol lighting.

Our luminous ceiling installation in the new county courthouse holds glare to a minimum while providing the necessary high intensity for the readability of small type, script and figures.

In addition to the office of the Recorder of Deeds, other areas of the building are profiting by these translucent luminous ceilings which use corrugated white Plexiglas in 3'-0" x 5'-0" sections. This material won't shrink, crack or change color. Note its flexibility — how it has been cut and shaped around columns, for example.

Litecontrol specializes in industrial installations which diffuse good light without glare so that folks can read documents, books or dials clearly or see merchandise better. For courthouses, libraries, schools, control rooms, banks, offices, stores and other public and commercial structures. What's more you will probably save money because many of our installations use standard fixtures right out of our catalog.

INSTALLATION
York County Court House, York, Pennsylvania
AREA SHOWN
Recorder of Deeds' Office
ARCHITECT
Forrer-Baer Associates, York, Pennsylvania
ENGINEER
Albert C. Dudrear and Son, York, Pennsylvania
GENERAL CONTRACTOR
R. S. Mowery & Sons, Carlisle, Pennsylvania
ELECTRICAL CONTRACTOR
Paul L. Kissinger, York, Pennsylvania
DISTRIBUTOR
Jno. E. Graybill Company, York, Pennsylvania
ROOM FINISHES
Walls, pale blue — Floor, gray
FIXTURES
Litecontrol luminous ceiling, using white corrugated Plexiglas panels; 40 watt rapid start lamps are spaced on 36" centers, 18" above top of plastic.
INTENSITY
Average, 115 footcandles initially

LITECONTROL
Fixtures
KEEP UPKEEP DOWN
LITECONTROL CORPORATION,
36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

Joseph B. Browder
IES President, 1959-1960

SOME 25 years ago, an energetic young Kentuckian in the class of 1935 at the U. S. Naval Academy faced a decision–whether to follow the life of a naval officer or to seek a new career. Had Joseph Briggs Browder elected to continue his Navy career, the Illuminating Engineering Society undoubtedly would be without the services of its first Southern President in its half century of history. The lighting and engineering profession itself would be an even greater loser, for the contributions he has made to those fields in the past quarter of a century have been innumerable.

Among the accomplishments of the new IES President, who is currently employed as sales manager of the Georgia Power Co., are:

• He was the organizer and key figure in 1948 of a committee of the Georgia Section which prevailed successfully upon the Georgia Board of Registration of Professional Engineers to recognize illuminating engineering as a separate profession. (It previously had been considered as an adjunct to electrical engineering.) As a result of this he became the first registered illuminating engineer with the Georgia Board of Registration for Professional Engineers.

• Under his leadership, as manager of the company's lighting division, the Georgia Power Co.'s lighting training course was developed to such a high degree that *Electrical World* magazine used it as a "bench mark" for a national survey of utility training courses in 1954. The course was pronounced the finest in the country. It is freely given to many people other than company personnel and numbers among its graduates some of the region's most distinguished lighting engineers and IES members.

• He is one of the founders of Atlanta's nationally known Architects and Engineers Institute. Mr. Browder was one of a group of architects and engineers who in 1956 conceived, organized and successfully established the Institute. With $50,000 of borrowed money, they purchased an 80,000-square foot building in downtown Atlanta. The $450,000 structure, which provides free office space and meeting rooms for all 32 architectural and engineering societies (including IES) in Atlanta, is being amortized by the permanent displays of building materials and electrical exhibits of the Atlanta Electrical League, also organized by the group. The electric displays, which occupy the entire second floor of the building, constitute the largest permanent exhibit of lighting equipment in the nation. Courses in lighting at the Institute are now given, by the Atlanta Electrical League, to contractors, architects, and engineers. Mr. Browder is the Institute's First Vice-President and is serving his second three-year term on the Board of Directors, which consists of four architects and four engineers.

• Joe Browder is the man who spearheaded a post-war five-year lighting plan for the City of Atlanta which has earned the city the title of "one of America's Best Illuminated Cities." He was responsible for the Atlanta City Council passing a resolution legally adopting the "American Standard Practice for Street and Highway Lighting" as a standard for all city streets.

• He is the organizer and chairman of a unique and vitally important committee for encouraging science education—the Atlanta Citizens Committee for Science Education. Operated by 15 civic-minded citizens, the organization encourages education in

science, raises funds to provide science scholarships to deserving youngsters, and finances the attendance of outstanding students and teachers at the National Science Fair. The City of Atlanta entries in the National Science Fairs have, in the five-year history of this event, won more awards than entries from any other American city. Mr. Browder is very proud of the fact that this committee was formed *before* the first Sputnik was ever launched.

• Mr. Browder, together with two women of the Atlanta school system single-handedly raised $35,000 for building and equipping a biological science laboratory-classroom at the newly rebuilt Atlanta Zoo. The school system staffs the lab and takes 100 students at a time, with the other biology classes throughout the city receiving the live animal instruction on closed-circuit television. The various animals being studied are supplied by the Zoo. Atlanta is the nation's second city to have such a project as this.

• He has held nearly every office of the Georgia Section of IES, including that of Chairman. He was Southern Regional Vice-President for three years, during which term the Southern Region added five Chapters to its two Sections, thus bringing the Southern Region into national prominence. He served as Chairman of the National Technical Conference Executive Committee for the 1957 Atlanta National Conference.

• He is currently Second Vice-President of the Georgia Engineering Society which has over 1200 members from all branches of engineering, and has just completed serving two years as Vice-Chairman and two years as Chairman of the commercial section of the Southeastern Electric Exchange, a trade organization similar to the Edison Electric Institute, composed of 26 Southeastern electric utilities. Other organizations to which he belongs are the International Association of Electrical Inspectors, the National Society of Professional Engineers and the Georgia Society of Professional Engineers, the United States Naval Institute, and the Lions Club.

Holding the responsibility for all nine divisions of the Georgia Power Co.'s sales department, which includes rates and sales advertising, and the more than 300 employees who comprise these divisions and working with the many organizations and projects listed here would more than tax the ingenuity —and time limitations—of an ordinary man. However, a quick review of Joe Browder's "off-duty" activities quickly convinces one that here is no ordinary man.

He follows a colorful hobby trail ranging through astronomy, anthropology, cabinet making, power boating, water skiing, fishing, hunting, photography, and more recently, Scuba diving. The most impressive proof of his hobbying skills is the Browder residence into which he first moved when he came to Atlanta in 1945. When Mr. and Mrs. Browder moved from Columbus, Ga., the residence they bought was "just another old house." The energetic couple went to work, completely remodeling the house inside and out, doing all the work themselves.

They turned the home into a prime example of better living, much of it made possible by a variety of electrical devices which the versatile Mr. Browder either utilized or invented. The home was not only featured in local newspapers but was the second in a series of articles in McCall's magazine, which devoted six pages of color pictures to the story.

That "project" completed, the Browder's next turned their talents to a new home. To most people, building a new home means selecting a set of plans, calling in a contractor, and telling him to go to work. To the Browders, however, the term means exactly what it says. Today their residence is one of the show-places of Atlanta, and except for the rough framing and brick veneering, they built it entirely by themselves. It contains twelve rooms and took them four years to complete. They even did the plumbing, wiring, heating, the woodwork, the floors, walls and ceilings.

As for Mr. Browder's career with the Georgia Power Co., it has been one of frequent promotions and invaluable service to the company in a variety of posts. His utility career actually started as a lighting sales engineer with the Tennessee Electric Power Co. in Nashville in 1935. With TVA's subsequent purchase of the company four years later, Mr. Browder came to Georgia Power as a lighting engineer. Three years later he was promoted to division lighting engineer in Columbus, then in 1942 was named industrial lighting engineer in the company's general office.

He has also served as Atlanta division lighting engineer, Atlanta division sales supervisor, manager of the company's lighting division and commercial sales manager for the company. In 1955 he was made Sales Manager and Assistant to the Vice-President in Charge of Sales, the position he presently holds.

Probably the most valuable thing Mr. Browder brings to the office of IES President is his experience and training as an administrative executive. As the Society grows in size and scope, the duties falling on the President and Council become more and more ones of administration and policy.

INTEGRATED
Lighting–Air Conditioning Systems

By W. S. FISHER
J. E. FLYNN

CURRENT lighting recommendations for commercial and industrial buildings have reached a point where the lighting load may have considerable influence on thermal design considerations. Continuing trends toward higher levels of illumination, as well as increased use of wall lighting and accent lighting, have introduced additional human comfort and economic factors, due to the heat introduced by the lighting system.

Estimates on the basis of conventional practice indicate that in office buildings where about 100 footcandles of general illumination are provided, the lighting load accounts for approximately 37 per cent of the total air conditioning requirements. If the load is increased to provide 400 footcandles, the lighting accounts for more than 70 per cent of the cooling capacity.[1]

On the other hand, many current examples of lighting in commercial and industrial areas testify that it is often economical and desirable to provide 100, 200 and 400 footcandles, notwithstanding the cost of supplying these levels with the necessary cooling. Also, techniques which combine certain aspects of air conditioning and lighting indicate the possibility of substantial reductions in overall costs. Some examples of integrated systems are now in existence.[2,3]

It has also been pointed out that these higher lighting loads can furnish much of the heat required for a building during cold weather, suggesting the possibility of providing both light and heat from the same system.

This paper presents some of the fundamental aspects of electric lighting as a heat source. It will make some suggestions for control of this heat and indicate ways to capitalize on its thermal properties through integrated lighting-air conditioning systems.

Analysis of Lighting System As a Heat Source

All electric light sources generate heat in addition to the primary purpose of producing light. Regardless of the type of lamp, heat is emitted at the rate of 3.415 Btu/watt-hour of energy consumed. From this factor is derived the conventional "rule of thumb" that one ton of cooling capacity is required to remove the heat from approximately 3500 watts of lighting load.

While these factors remain constant for all light sources, they are related to "energy consumed" and not "light output." The fluorescent lamp, therefore, having approximately three times the luminous efficacy of an incandescent lamp, can be said to produce only about one-third the heat load per lumen. This establishes an initial thermal advantage for the fluorescent system, but detailed study of these two light sources establishes more fundamental differences in their characteristic operation as heat sources—differences which have an important bearing on the thermal comfort of lighted rooms.

Figs. 1 and 2 show the dissipation of lamp watts from an incandescent and a fluorescent source with all of the wattage eventually becoming heat energy. While the lamps considered were approximately equal in lumen output (150-watt incandescent and 40-watt fluorescent), the figures shown indicate the dissipation as per cent of the total lamp wattage in each case. This is illustrated in a comparison of the convection-conduction heat generated by the two lamps. As a per cent of the total input, this heat represents a smaller proportion for the incandescent system than for the fluorescent system. However, if a comparison is made for equal light output, we see that for incandescent load, this form of heat is 20 per cent of 150 watts, or 30 watts. Approximately the same light output from a fluorescent lamp and ballast produces 41 per cent of 45 watts, or 18.5 watts of convection-conduction heat. So, while the percentage figures may appear higher, the difference in luminous efficacy must be kept in mind when drawing conclusions from the illustrations.

Another very important factor which must be kept in mind is that the light source is seldom an operating entity in itself. A more realistic picture might be visualized by noting the heat emission characteristics of the lamp-luminaire combination.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. AUTHORS: General Electric Co., Cleveland, Ohio. A Transaction of the I.E.S.

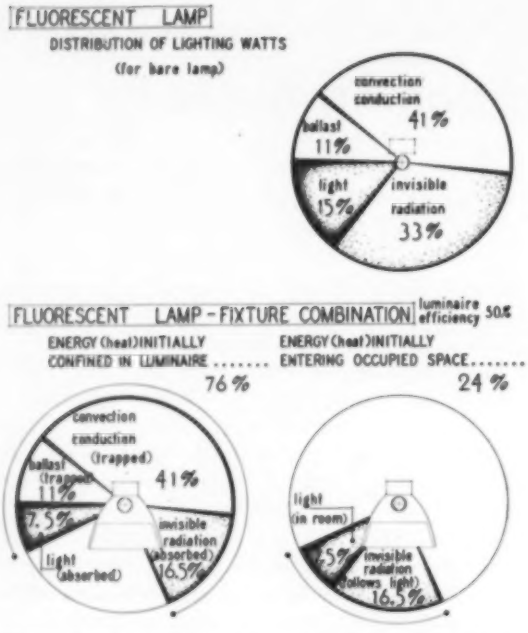


Figure 1. Energy output for a 40-watt fluorescent lamp plus five watts ballast loss.

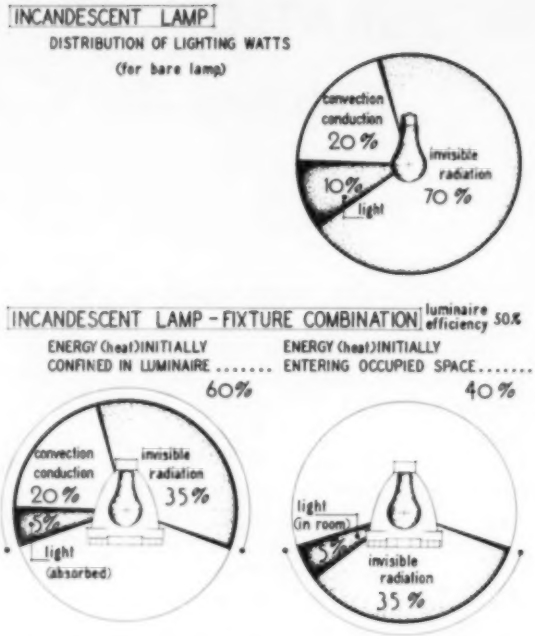


Figure 2. Energy output for a 150-watt incandescent lamp.

First, it should be noted that any reduction in light output due to luminaire absorption is accompanied by a similar reduction in invisible radiant energy, as the two "follow each other" and have similar characteristics. When light (and invisible radiation) is intercepted and absorbed by the luminaire, this loss is converted into heat within the luminaire itself. Radiant transfer, the transfer of heat directly between two objects or surfaces, is effected between the warm lamp and the cooler luminaire surfaces.

Heat build-up within the luminaire may become substantial, with the convection-conduction heat and the ballast load initially trapped in the unit and a portion of the radiant energy absorbed by the luminaire surfaces. This confinement of heat will also increase the temperature of the ceiling and ceiling cavity (if any). If the build-up is allowed to continue, the luminaires and adjacent ceiling area become "secondary heat sources," the heat being carried into the occupied parts of the room by convection or re-radiation to cooler objects and surfaces.

To illustrate the point with a fluorescent example, it is noted that each 40-watt lamp plus its ballast will introduce approximately 154 Btu/hr. (3.415 x 45 watts) into the room. Ordinarily the entire load will eventually become a factor on the comfort of the space (and on the air conditioning requirements).

A study of the heat characteristics of the lighting system shows that the bare lamp itself dissipates 41 per cent of the lamp-ballast wattage as convection-conduction heat. This heat plus the ballast load is, initially, trapped in the unit. In addition, a luminaire efficiency of 50 per cent means that one-half the light plus invisible radiation is absorbed by the luminaire surfaces. Therefore, approximately 76 per cent of the total heat produced is initially restricted to the luminaire. If this heat or a substantial part could be drawn off without having it enter the occupied space, the lighting load which affects occupant comfort could be as little as 37 Btu/hr. (as compared with the

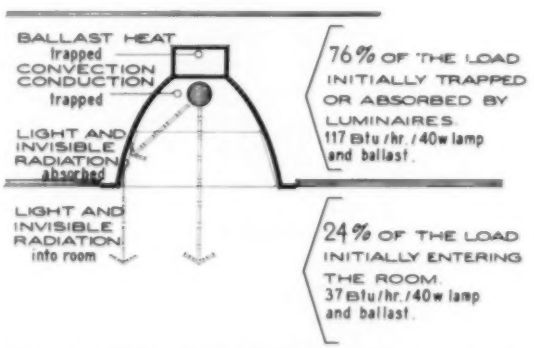

BALLAST HEAT trapped
CONVECTION CONDUCTION trapped
LIGHT AND INVISIBLE RADIATION absorbed
LIGHT AND INVISIBLE RADIATION into room
76% OF THE LOAD INITIALLY TRAPPED OR ABSORBED BY LUMINAIRES. 117 Btu/hr./40w lamp and ballast.
24% OF THE LOAD INITIALLY ENTERING THE ROOM. 37 Btu/hr./40w lamp and ballast.

Figure 3. Distribution of heat energy by a luminaire. Heat trapped or absorbed by the luminaire is removable before it enters the occupied space.

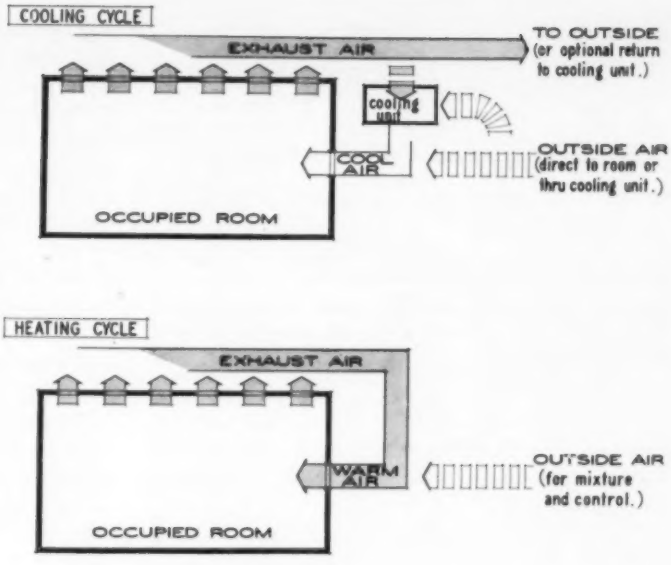


Figure 4. Schematic diagram of a method for controlling luminaire heat. Air is usually exhausted to outside on cooling cycle, re-circulated on heating cycle. Other variations are indicated.

154 Btu/hr. for the lamp and ballast as conventionally considered).

In theory then, for the luminaire condition noted, every 40 watts of fluorescent lighting (plus five watts ballast loss) will introduce 37 Btu/hr. in a form which becomes an immediate factor on occupant comfort. This heat must be offset by cooling in the room itself, unless heating is desired (Fig. 3). With this, an additional 117 Btu/hr. are in a location and form which can be controlled in some degree. This latter heat may be drawn off by ventilation (and/or cooling) in warm weather before it enters the occupied space, or it may be allowed to enter the space in cold weather to reinforce (or even replace) the heating system. A similar picture might be derived for the incandescent system.

Under any circumstances, an uncontrolled build-up of heat in a fluorescent luminaire is undesirable for its adverse effect on light output and lamp efficiency. For example, a T12 lamp operated at 430 ma in a 100F ambient is about 12 per cent lower in light output than at 77F.[4] A need for moving this heat away from the lamps and either into the room or away from it is therefore indicated, not only for room comfort, but also for improved lamp and ballast operating conditions.

Integrated Light-Heat System

Under many conditions the heat produced by modern lighting systems is sufficient to compensate for normal heat losses in the room. A prerequisite for use of this heat is a method of control to regulate the output as the weather moderates.

Fig. 4 indicates proposals for the control of the lighting heat. Air movement through the luminaire will carry off substantial portions of this heat before it builds up. Exhaust air is pulled out of the space through the lighting system, carrying the heat away before it affects room comfort. For room cooling, this air may be moved directly to the outside and replaced by new, cooler air or, when the exhaust temperature is lower than the outdoor air, it may be re-circulated through the cooling system.

Air circulation in cold weather may be through the system in a similar manner, where it picks up

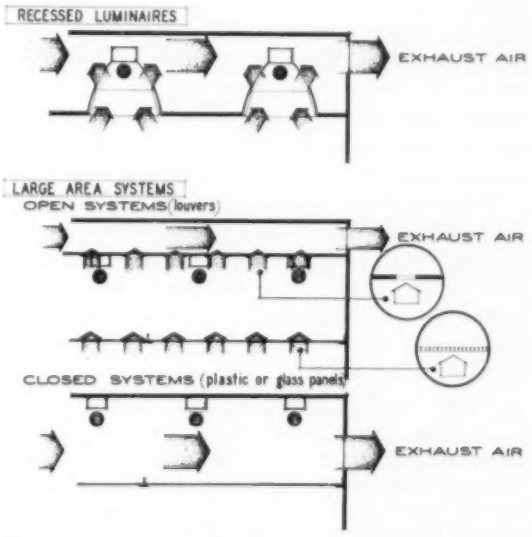


Figure 5. Methods of heat removal for several types of lighting and ceiling construction. Room air and/or filtered outside air may be used.

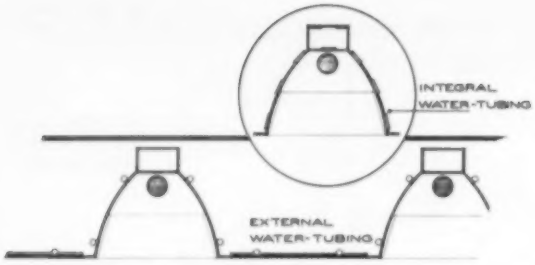


Figure 6. Circulating water as a means of heat removal. Mechanically attached tubing or sheet metal with integral tubing may be used.

heat and then is returned to the occupied part of the room to reinforce (or even replace) the heating system.

Fig. 5 illustrates methods for control of lighting heat with air circulation in several types of lighting systems. For sealed luminous ceilings, filtered outside air could be used for ventilation instead of room air. Outside air will remove heat until its temperature is equal to or higher than the normal lighting system ambient. In single story buildings with suspended ceilings, ventilation of the cavity space with outside air may also remove much of the solar heat (which can be considerable in such structures).

An alternate (or supplement) to the use of air for heat control is the use of water-cooled panel systems. Luminaires utilizing sheet metal with integral tubing, used presently for refrigerators (Fig. 6), may offer such integrated control.[3] Use of water-cooled systems also implies a reduction in building volume and material requirements when water tubing is used in place of more bulky air ducts. It should be remembered, however, that water cooling does not eliminate the need for air in a room, since minimum fresh air requirements must still be maintained.

Through some variation or combination of the illustrated techniques, the effect of heat from the lighting can be controlled. A large portion of the heat output is in a form subject to control and regulation by ventilation and cooling of the lighting system. If this control is achieved, the remaining heat, which enters the occupied part of the room and directly affects comfort, may be less for the integrated system which meets today's illumination standards than for lower lighting levels where current air conditioning practice allows all of the lighting heat to enter the occupied space before it is removed.

Practical Application of the Principles

The performance of one type of integrated lighting-air conditioning system has been verified in a full-scale installation at Nela Park. The room is an office demonstration area 25 feet by 35 feet. The space is also used as a classroom and, as such, may be occupied by as many as 60 persons continuously for several hours. In planning the complete integrated design for this room, it was desired that the space be visually and thermally comfortable when lighted to about 500 footcandles. This integrated system has demonstrated the feasibility of these design objectives on many occasions.

There are a number of lighting systems in the room including several for lighting the wall areas. The system tested consists of louvered troffers, 24 inches wide, each employing four 1500 ma lamps of non-circular cross-section (Fig. 7). The lamps are operated on a dimming circuit developed for this installation and the dimming chokes and transformers were located remotely for convenience.

Slots are provided in the luminaire reflector through which air may be exhausted at a desired rate. The cavity between reflector and the back of the unit serves as an air duct integral with the luminaire. Each row of luminaires is then connected to a main exhaust duct. Data were obtained to determine the heat removed from the luminaire by air exhausted through the unit. This information is presented in Fig. 8.

The curves of Figs. 8a and 8b are for three lamp loadings representing about 25 per cent, 50 per cent and 100 per cent of the lamp watts. Data for both (a) and (b) are the same, but are shown in different ways. The temperature differential between lamp bulb wall and air is greater at higher loadings, so the rate of heat transfer and the total

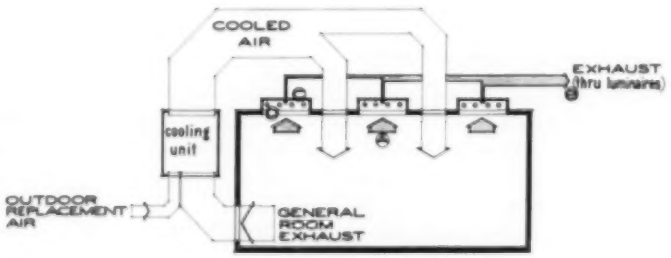


Figure 7. Schematic diagram of integrated lighting-air conditioning system tested. Part of the room air is exhausted through luminaires, the remainder cycled to cooling unit. Air removed through the luminaires is exhausted to the outside in warm weather, recirculated to central system for heating during cold weather.

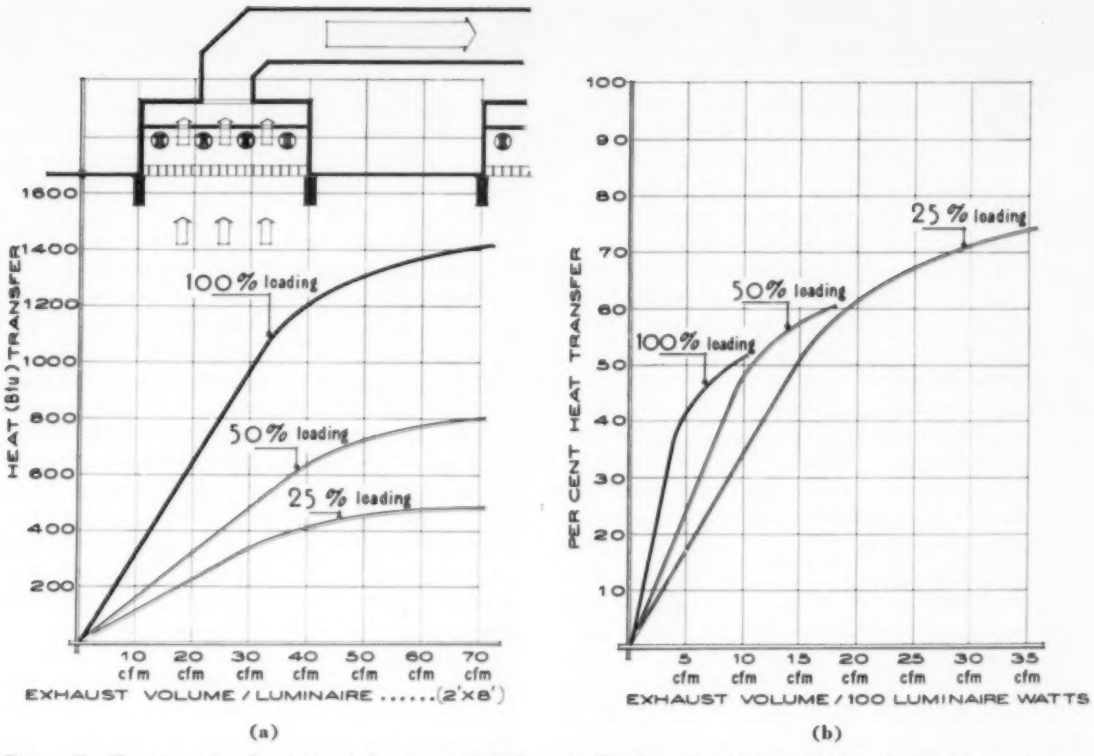


Figure 8. Heat transfer for integrated system plotted on two different bases: (a) notes the removal of heat in Btu/hour/luminaire tested, and (b) charts the per cent heat removal per 100 luminaire watts.

heat removed are proportionately higher (Fig. 8a). However, the percentage of total heat removed by a given volume of air is greater for the lower loadings. Air temperatures other than those used in the test and different luminaire designs may change the shape and relationship of these curves.

In practical installations with ballasts mounted in the luminaires, the heat transfer curves might be slightly steeper, as the same air flow should efficiently pick up most of the ballast heat. When the ballast is completely enclosed by the luminaire, its energy is largely available in the form of conduction and convection heat.

It will be noted that heat transfer of more than 70 per cent was observed for the 25 per cent loading. This is close to the maximum heat available, assuming this condition simulates that indicated by Fig. 1. However, it was noted that the light output for this exhaust condition was about 10 per cent less than for lower exhaust rates, indicating that if heat transfer approaches the maximum available, there is a possibility of cooling lamps below their optimum operating temperature.

The test condition of most significance is that for full loading of the non-circular cross-section lamps. When 4 cfm of air are exhausted through the luminaire for each 100 watts, then approximately 40 per cent of the heat energy is removed (Fig. 8a). This is about 55 per cent of the heat available for removal from the fluorescent lamp and luminaire combination. (Tests at lower loadings were performed for the indications they provided and should not be applied as typical for lamps of other sizes and loadings).

Without ventilation, luminaire reflector temperatures of about 128F resulted with lamps operated at 1500 ma (Table I). At this temperature, the reflector is a source of radiant energy comparable with a panel heating system and can exert a substantial influence on the thermal comfort of a room. The presence of radiant energy was quite apparent to the authors under this condition despite a maintained room temperature of 72F. With about 4 cfm of air for each 100 luminaire watts exhausted through the lighting units, reflector temperatures dropped to the vicinity of 110F which mitigated the radiant heating effect in the room. Reactions of hundreds of people who have occupied the room indicate this latter radiant heating effect is entirely acceptable for the maintained room temperature conditions.

In some commercial areas where ceiling heights

TABLE I—Test Data from Integrated Lighting-Air Conditioning System. (Letter Designations Refer to Test Locations Labelled in Fig. 7.)

Exhaust Volume per Luminaire (cfm) "A"	Watts per Luminaire	Average Illumination (fc)	Room Temperature Degrees F	Duct Temperature Degrees F "B"	Luminaire Reflector Temperature Degrees F "C"	Luminaire Air Temperature Degrees F "D"
0	800	335	72	—	128	126
16	800	377	72	102	118	104
28	800	385	72	101	111	99
66	800	406	72	91	101	89
0	400	234	72	—	—	96
15	400	235	72	90	—	87
28	400	237	72	88	—	86
69	400	233	72	83	—	83
0	200	115	72	—	—	88
17	200	122	72	84	—	84
30	200	119	72	82	—	82
68	200	107	72	78	—	79

may be as low as 9 feet, two-lamp or single-lamp luminaires employing 1500 ma lamps of non-circular cross-section are needed for practical spacing of units in 100- to 200-footcandle lighting systems. Luminaires sealed for the same loading as those of this test, *e.g.*, six inches of width for each lamp with slots between lamps, should have heat transfer characteristics similar to the curves of Fig. 8.

Luminaires of the type employed in this test are practical for many present-day commercial and industrial lighting installations, since ventilation makes possible the use of lamps of greater loading. This can substantially reduce the initial cost of lighting systems and lower the over-all cost of light. In addition, new techniques for controlling luminaire brightness with reasonable efficiency are now available which can function satisfactorily for lumen loadings even higher than those of the luminaire used in this test. [5]

Application of Test Data

The implications of these data on a practical installation are of interest. A hypothetical multistory office building of conservative modern design (35 per cent glass area) was analyzed in a previously published paper on lighting and air conditioning.[6] The data on ventilated luminaires can be extended to this structure. For example, a luminaire employing a single 1500 ma lamp of non-circular cross-section is assumed to provide the lighting. Its design is such that the heat transfer curve of Fig. 8b applies. About 100 footcandles can be provided in a medium-sized office with luminaire rows five feet apart. If 4 cfm of air are exhausted through the luminaires for each 100 watts, then approximately 40 per cent of the lighting heat load can be removed.

In large office buildings, average practice provides about 27 cfm of fresh air for each occupant, so that the room air will not become stale. In addition a building occupancy of one person for each 100 square feet can be assumed. To allow for the fresh air, an equal amount of the building air must be "bled off." Some of the 27 cfm per person is exhausted through toilet rooms while a small amount is used for "pressurization" to maintain the building air at a slightly higher pressure than the outside air. These requirements may take about one-third of the waste air, which leaves two-thirds available for luminaire exhaust. This amount (about nine per cent of the total air supply) is very nearly equal to that required to carry off 40 per cent of the luminaire heat. So, with no increase in primary air supply, the air conditioning needed to take care of 100 footcandles in this integrated system is only 60 per cent of that for a conventionally cooled installation. Fig. 9 shows the relationship between illumination level and the air conditioning tonnage required for conventional and integrated systems. Further, the volume of

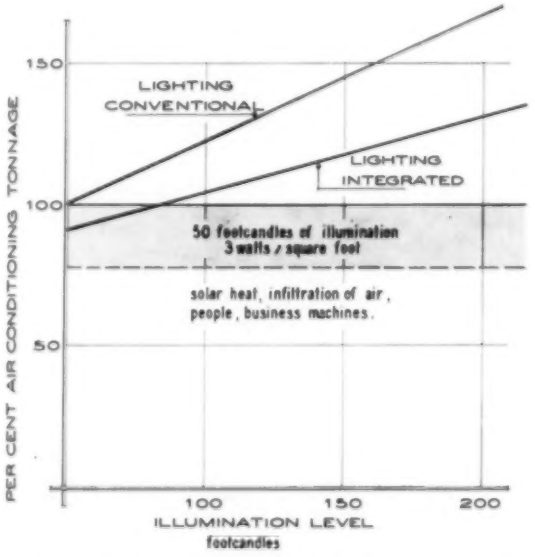


Figure 9. Variation in air conditioning tonnage with illumination level for conventional and integrated systems.

air required, being proportional to the tonnage, means a reduction in air handling equipment.

Analysis of air conditioning costs to provide for lighting in the large office building example indicate that increasing the illumination from 50 to 100 footcandles, with conventional lighting and air conditioning systems, requires an increase in initial costs of about 93 per cent. This amounts to an approximate increase of 18 per cent in the over-all air conditioning installation. However, if an integrated lighting-air conditioning system of the type just described is employed, the increase in cost for air conditioning is only about 57 per cent (or 12½ per cent of the over-all). This latter figure includes the cost of the extra air handling system needed to exhaust the luminaires. (Perhaps integrated systems, where 20 or 30 per cent of the lighting load is removed to the outside, will also prove attractive in reducing initial costs of air conditioning).

At illumination levels above 100 footcandles, more air for exhaust through luminaires will be needed than is available for "waste" in typical office buildings. The additional air could be provided by circulating through the luminaires more air than would normally be "bled off." Under the extreme design conditions, *e.g.*, 95F, high humidity out-of-doors, it may prove to be more economical to recirculate this heated air. However, in mild weather it is usually better to exhaust all of it to the outside. Automatic thermostically-controlled dampers ("economizer systems") could be used to select the most favorable condition. These devices are presently being used to select the most economical operating mixture for particular weather conditions.

In many types of public buildings, such as auditoriums, arenas, and exhibition halls, the density of occupancy may be higher than in office buildings. In addition, there may be considerable smoking or vigorous physical activity which would call for substantially more fresh air than the 27 cfm per person supplied in offices. Thus, the percentage of "make-up" air may be 25 per cent of the total air supply or higher. This quantity of "throw-away" air makes integrated lighting-air conditioning systems especially attractive for these areas.

Method of Analysis for Heating and Cooling of Buildings

The use of higher lighting levels may be altering the entire economic picture with regard to mechanical services. Ways to reduce the cooling costs (and lighting costs) have been suggested. Further gains in over-all economics can be achieved by a substantial reduction in heating requirements, since lighting may furnish a significant part of the total heat needed for a commercial or industrial building. Techniques such as panel heating and cooling or the heat pump may perform more economically when combined with the heat from a lighting system.

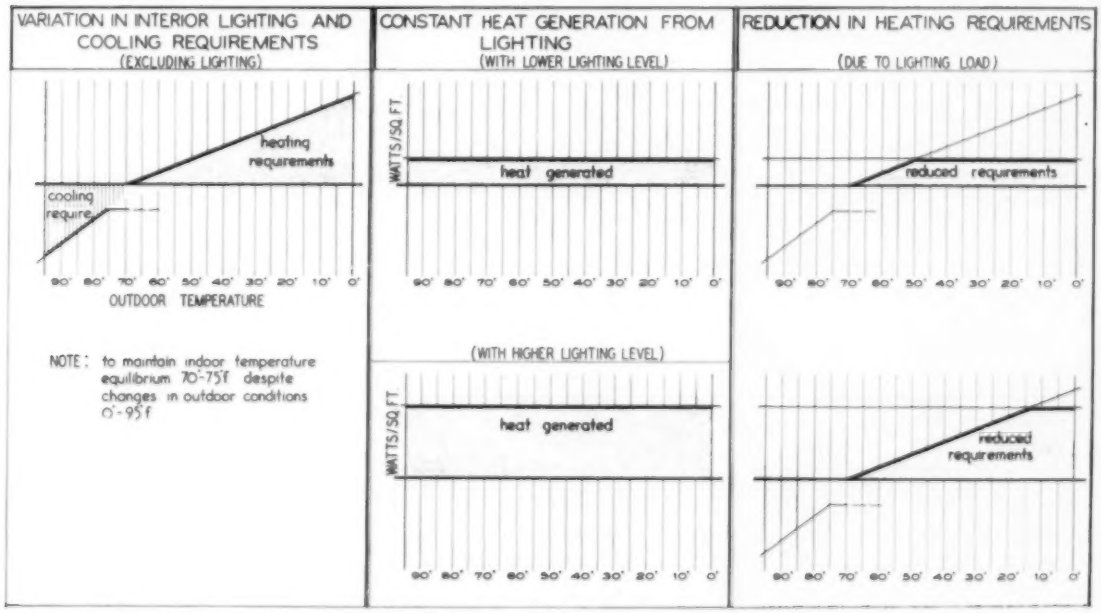

VARIATION IN INTERIOR LIGHTING AND COOLING REQUIREMENTS
(EXCLUDING LIGHTING)
heating requirements
cooling require
90° 80° 70° 60° 50° 40° 30° 20° 10° 0°
OUTDOOR TEMPERATURE
NOTE: to maintain indoor temperature equilibrium 70°-75°F despite changes in outdoor conditions 0°-95°F
CONSTANT HEAT GENERATION FROM LIGHTING
(WITH LOWER LIGHTING LEVEL)
WATTS/SQ FT
heat generated
90° 80° 70° 60° 50° 40° 30° 20° 10° 0°
(WITH HIGHER LIGHTING LEVEL)
WATTS/SQ FT
heat generated
90° 80° 70° 60° 50° 40° 30° 20° 10° 0°
REDUCTION IN HEATING REQUIREMENTS
(DUE TO LIGHTING LOAD)
reduced requirements
90° 80° 70° 60° 50° 40° 30° 20° 10° 0°
reduced requirements
90° 80° 70° 60° 50° 40° 30° 20° 10° 0°

Figure 10. Effect of lighting on heating requirements.

A method of analyzing the heating and cooling requirements of buildings is presented by steps in Figs. 10 and 11. Consideration of the heat from the lighting has, until recent years, been primarily with relation to the increased cooling requirements. As seen in Fig. 10, the levels of illumination in practice were relatively low and the effect on total heat requirements insufficient to warrant special provision for utilizing it. Fig. 10 further indicates the substantial portion of the total heat supplied as levels of illumination have increased in recommendation and practice.

Estimation of heat losses in the office building example cited earlier indicates that for a New York location a uniform lighting level of 100 footcandles would supply enough heat to replace about two-thirds of the heat losses for the outdoor condition of 0F and 15 mph wind. Increasing the level to about 150 footcandles of fluorescent lighting, therefore, introduces a total heating load approximately equal to the building losses. Full utilization of this heat would require careful control and distribution throughout the building (see Fig. 4). The presence of such a load becomes an important economic factor in appraising the total value of the lighting system. For commercial or industrial property where the management must (or chooses to) build its own heating plant, the utilization of lighting as the principal heat source can mean substantially reduced capital investment in boilers, chimneys, and distribution systems.

On the other hand, the potential advantage of reduction in heating requirements may be somewhat offset by an over-all increase in cooling requirements. It is here that the fundamental importance of Figs. 1-3 becomes apparent. If it is possible to control a considerable portion of the lighting heat and remove it before it becomes a factor in room comfort, then the actual effect of the increased load on air conditioning tonnage and on occupant comfort may not be as great as anticipated by today's conventional methods.

Fig. 1 noted that for our example fluorescent system, up to 76 per cent of the total heat is subject to some control. Fig. 11 then indicates the maximum extent of this substantial quantity, implies the impact on room temperature, and underlines the importance of removing it in warm weather before it enters the occupied portion of the room.

Normal ventilation equal to or exceeding the basic building code requirements can be utilized to remove and control part of the heat accumulation. During moderate weather, careful use of this outside air, as a thermostatically-controlled mixture of outdoor and recirculated air, may be sufficient to maintain room comfort.

Fig. 11 also notes this heat-regulating effect of controlled room ventilation and indicates the possible increase in efficiency when this same air is passed through a higher ambient and used to ventilate and cool the luminaires as well as maintain room temperature.

As outside temperatures rise and the ventilation

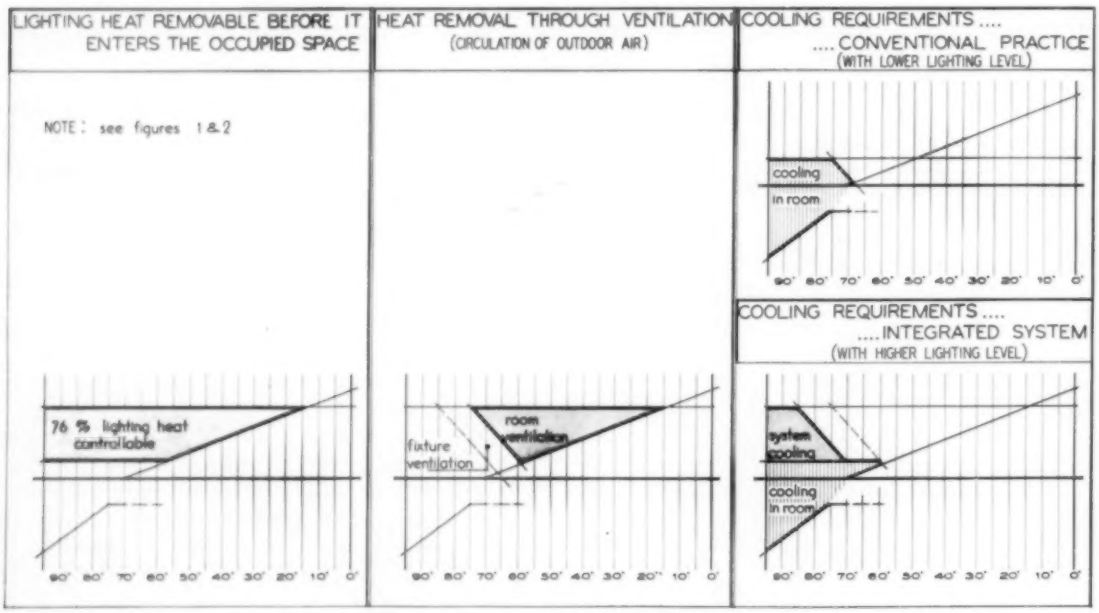

LIGHTING HEAT REMOVABLE BEFORE IT ENTERS THE OCCUPIED SPACE
HEAT REMOVAL THROUGH VENTILATION (CIRCULATION OF OUTDOOR AIR)
COOLING REQUIREMENTS .... CONVENTIONAL PRACTICE (WITH LOWER LIGHTING LEVEL)
NOTE: see figures 1 & 2
cooling
in room
90° 80° 70° 60° 50° 40° 30° 20° 10° 0°
COOLING REQUIREMENTS ....INTEGRATED SYSTEM (WITH HIGHER LIGHTING LEVEL)
76 % lighting heat controllable
room ventilation
fixture ventilation
system cooling
cooling in room

Figure 11. Effect of lighting on cooling requirements.

system alone is no longer sufficient to maintain room comfort, a cooling system becomes necessary, both in the occupied portion of the room and in conjunction with the lighting system.

The last portion of Fig. 11 compares current cooling practice, where all of the heat enters the room before it is removed, with a higher level system and the integrated approach proposed in this paper. In the latter case, the considerable heat initially confined in the lighting system is removed before it enters the occupied space, and the actual heat load that affects room comfort may be less for the higher level system than for the lower level system cooled by conventional techniques.

Summary

Certainly there are many interrelated factors involved here. For example:

(1) Need for illumination levels compatible with the tasks involved—levels in line with current recommendations;

(2) Need to replace heat losses during cold weather for the maintenance of thermal comfort;

(3) Parallel need for techniques to remove heat generated by the lighting system in warm weather and again maintain thermal comfort in the room;

(4) Desire to achieve maximum efficiency from the lighting system involving maintenance of near-optimum ambient temperature conditions for the lamp and ballast.

Taken individually, each of these involves an investment for the user, but considered as an integrated problem, expenses incurred in one phase may result in savings in another. For example, if the increased cost of controlling and removing the lighting heat can be accompanied by a comparable reduction in heating cost (both installation and operation), then the application of this approach becomes economically feasible.

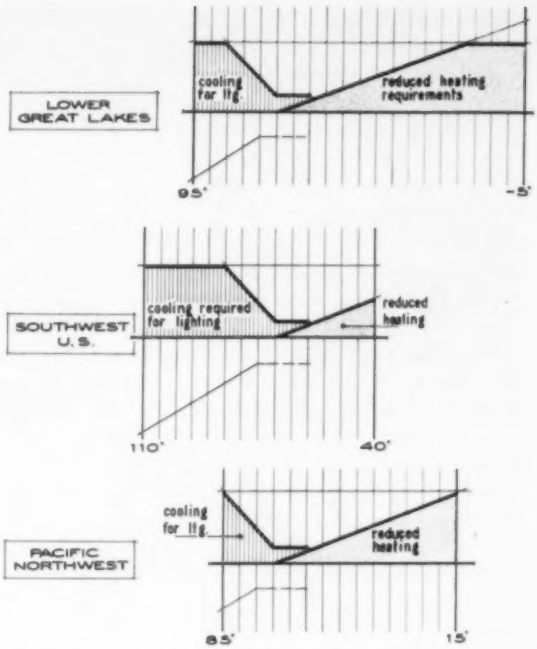


Figure 12. Variability in thermal design conditions for three geographic locations.

In the final analysis, the economic practicality of a single integrated system for heating, cooling, and lighting must be determined by local conditions. Fig. 12 notes the variability of design conditions for three sections of the country. While the lighting load remains constant, it is apparent that the relative seasonal value of reduced heating versus increased cooling requirements changes considerably. On the other hand, in the extreme warm climate, the potential economic advantage of reduced tonnage requirements (Fig. 9), or the need for reducing the heat in the occupied zone, may be

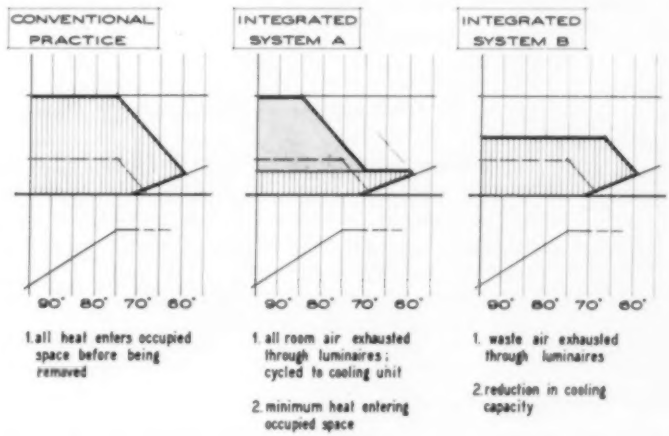

CONVENTIONAL PRACTICE
INTEGRATED SYSTEM A
INTEGRATED SYSTEM B
90° 80° 70° 60°
1. all heat enters occupied space before being removed
1. all room air exhausted through luminaires; cycled to cooling unit
2. minimum heat entering occupied space
1. waste air exhausted through luminaires
2. reduction in cooling capacity

Figure 13. Advantages of integrated systems for improving room comfort and reducing tonnage with present recommended lighting levels. The effect of lower lighting levels handled by conventional practice is shown in dotted lines for comparison. Integrated system "B" illustrates the performance of the installation tested in this paper.

even more critical from the standpoint of maintaining occupant comfort and lamp operating conditions. Fig. 13 indicates the advantages of integrated over conventional systems for comfort and for reduced costs.

Still another factor which must be considered is the possible combination of these techniques with other heating and cooling systems. For example, the winter heating load usually determines the size of a heat pump, with summer cooling capacity as a bonus. The reason for this is the wide differences between indoor-outdoor temperature gradients of summer and winter. In summer, the machine must produce an indoor-outdoor differential of 15 to 20 degrees, while the winter conditions call for 70- to 75-degree gradients. If the lighting load can be combined with such a system, however, the resulting reduction in winter heating requirements may make the application of heat pumps more economical.

Consideration of ventilation and cooling systems integral with the lighting design, then, offers a number of potential advantages:

(1) From an air conditioning standpoint, such a system offers the possibility of substantial heat reduction in rooms, so that heat is evacuated before it becomes a factor on occupant comfort; and reduces the tonnage requirements and quantity of air (cfm) required for regulating the heat in occupied spaces.

(2) The control of this heat, for use in cold weather or evacuation in warm periods, introduces the potential application of lighting as a heating system. Such a system might be used alone or in conjunction with other systems.

(3) The prevention of uncontrolled heat build-up in the lighting system induces ambient conditions more favorable for highly efficient operation of fluorescent lamps and ballasts.

Acknowledgments

The authors wish to thank Messrs. G. I. Wightman, P. Lucak, and M. Heppert, air conditioning engineers of Plant Engineering at Nela Park, who developed the details of the full-scale integrated lighting-air conditioning system. They also provided helpful counsel during the testing and evaluation of the system's performance.

References

1. Sturrock, W. and Schutrum, L. F.: "A Study of the Extraction of Heat from Fluorescent Luminaires in Air-Cooled Rooms," ILLUMINATING ENGINEERING, Vol. LII, No. 11, p. 569 (November 1957).

2. Hamel, J. S.: "Integrated Ceilings for Illumination," ILLUMINATING ENGINEERING, Vol. LIV, No. 4, p. 229 (April 1959).

3. Leopold, C. S.: "Design Factors in Panel and Air Cooling Systems," *Heating, Piping and Air Conditioning*, Vol. 23, No. 5, p. 115 (May 1951).

4. Underwood, P. J. and Beck, C. E.: "External Control of Mercury Pressure of Fluorescent Lamps and its Application to Luminaires," a paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif.

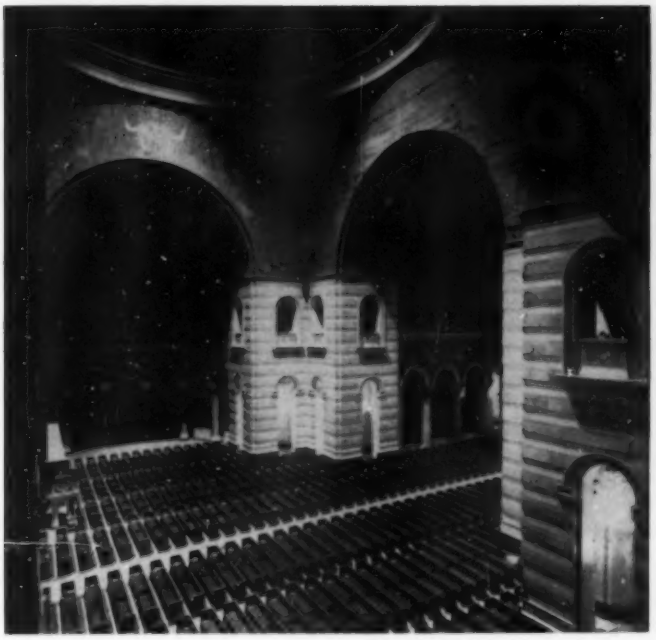
5. Dobras, Q. D. and Phillips, D. R.: "Designing Luminaires for Low Brightness at Higher Lighting Levels," ILLUMINATING ENGINEERING, Vol. LIV, No. 10, p. 627 (October 1959).

6. Benesch, E. J.: "The Effect of the Recommended New Levels of Illumination on Air Conditioning Design and Noise Control," a paper presented at the Building Research Institute Conference on Building Illumination, May 20-21, 1959, Cleveland, Ohio.

Discussion of Conference Papers in October IE

Since time between the National Technical Conference and the deadline for October IE did not permit publication here of discussion and rebuttal of this paper by Fisher and Flynn, this material, as well as discussion of other Conference papers in this issue (Dobras and Phillips, page 627; Massie and Rosenstein, page 636) will appear in subsequent issues of ILLUMINATING ENGINEERING.

Procedure for submitting this discussion is the same as that for all other Conference papers. See page 657 for instructions.



Mammoth downlight, weighing 1½ tons lights an area of over ¼ acre in the . . .

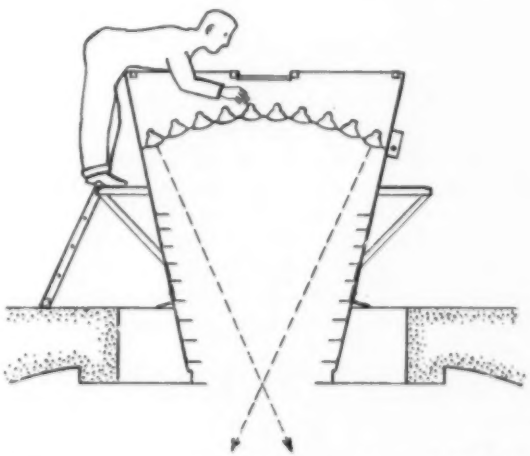
Cathedral of St. Louis

ARCHITECTURAL and esthetic considerations took precedence in the re-lighting design of the Cathedral of St. Louis, St. Louis, Mo.

The magnificent Byzantine building has a ceiling height of 143 feet at the center of the main dome. The dome itself is constructed of reinforced concrete, about 6 inches thick, and could not be pierced without cutting some of the reinforcing rods—which was prohibited. Individual recessed downlights spaced across the dome were, therefore, out of the question. In any event, the dome is soon to be covered with mosaic ornamentations. Hanging lanterns or chandeliers were also inadvisable, since they would cause a great deal of specular reflection from the existing rich mosaics on walls and arches.

The 8-foot-diameter oculus or eye at the center of the dome was, therefore, chosen as the most reasonable location for the lighting equipment, and a multiplicity of sources all focused through the single aperture the most practical solution. Thus, the multi-lamp downlight, and possibly the world's largest "recessed fixture," was developed. A total of 96 300-watt PAR56 spot lamps are mounted in a spherical base having its center in the center of the aperture. Therefore, the axes of all the lamps pass through the center of the aperture, making a composite conical beam.

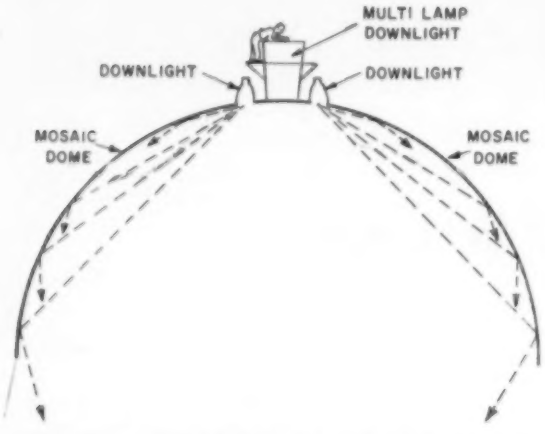
For uniform distribution at pew level, with each lamp emitting an oval-shaped beam, the lamp holders are arranged so that alternate lamps are placed with filaments on North-South and East-West



Cross-section through multi-lamp unit, probably the world's largest "recessed luminaire."

A section of the framework in which the 96 300-watt PAR 56 spot lamps are mounted.

Unit with lamps installed and exhaust fans mounted on the side to dissipate heat.



Shovel-type downlights light the surface of the main dome at steep angles, outside normal viewing directions.

axes. Horizontal baffles inside the body of the unit minimize aperture brightness and glare.

As finally installed, some 150 feet above the floor, the 1½-ton unit provides uniform illumination on a floor area of 11,700 square feet, or more than one-quarter acre. Dimming equipment provides the desirable flexibility in lighting level.

One of the problems occurring with 28,800 watts in one unit was that of heat. Two exhaust fans (one spare) are placed on one side of the fixture, and there are a series of louvered openings around the others for a uniform flow of air over the sockets. The unit was tested for temperature and performance data in accordance with the requirements of the National Electric Code.

On the downlight body, beneath the lamps, are two doors, hinged inward, so that when work is done on the fixture it can be sealed off to avoid the possibility of a lamp or tool—or even an electrician—falling through the 3-foot diameter aperture.

Supplementary lighting from 1500-watt floodlights in the Sanctuary and altar area increases the lighting levels at these focal spots to 20 footcandles at the Sanctuary and 40 footcandles at the High Altar and Archbishop's Throne.

Since all the light from the multi-lamp unit is downward over the pews, additional lighting was required for the mosaics which are to be installed in the main dome. Eight standard 1000-watt lamps with 360-degree shovel-type reflectors are mounted in a circle around the multi-lamp unit. Specularly reflected light from the walls of the dome is at such steep angles that it is outside normal viewing directions.

This installation won first prize in Class II of the St. Louis Section's 1958 contest for My Most Interesting Lighting Job. In was entered jointly by Herbert J. Zepf, of Maguolo & Quick, Architects-Engineers; Louis S. Sachs, of Sachs Electric Corp., Electrical Contractors; and Henry J. Poehling of E. H. Laugh & Associates, all of St. Louis, Mo.

Designing Low Brightness Luminaires For Higher Lighting Levels

By Q. D. DOBRAS
D. R. PHILLIPS

THE TREND toward higher lighting levels has steadily increased through the years. The new IES Recommended Levels of Illumination[1] includes general lighting levels up to 300 footcandles and levels of 500 footcandles or more are already in actual use. As lighting levels continue to increase, the problem of luminaire brightness control becomes more acute. Therefore, it is appropriate to develop new and improved methods of controlling luminaire brightness so that the users of light can obtain the benefits of these higher levels with good visual comfort.

It is the purpose of this paper to analyze one method of brightness control that has proven satisfactory for higher lighting levels and for use with higher brightness light sources. This method makes use of a specular wedge louver with parabolic curved sides.

This parabolic shaped louver has two unique advantages: (1) it permits complete brightness control in the shielded zone regardless of the size or brightness of the light source; and (2) it provides brightness control equivalent to black or dark gray louvers, but at a much higher efficiency.

Wedge Louver Design Principles

The objectives of this louver design are to minimize louver brightness in the shielded zone and to provide good lighting efficiency. These objectives are accomplished by utilizing the design technique illustrated in Fig. 1. In this illustration adjacent louver blades are shown. Line AD is a parabolic curve with the focus located at point B and the axis parallel to line AC. Line BC is also a parabolic curve but with the focus at point A and with the axis parallel to line BD. The axes for both parabolas form an angle with horizontal line CD equal to the shielding angle which, in this example, is 45 degrees.

All light passing through point B and reflected by specular surface AD is emitted at an angle of 45 degrees with respect to horizontal line CD. Any other light rays striking surface AD are reflected at angles greater than 45 degrees (closer to nadir). The same principles apply to light rays passing through point A and striking surface BC. With perfectly specular reflecting surfaces no light is reflected into the shielded zone; therefore, the theoretical louver brightness is completely independent of the size and brightness of the light source above.

However, the louver brightness is affected in the shielded zone by the brightness of room surfaces. In Fig. 2 the pattern of light reflections which originate below the louvers is shown. Most of the light rays tend to be reflected three times and emerge slightly displaced but at nearly the same angle at which they enter. This is illustrated by the 35-degree light ray. However, near horizontal the light rays may be reflected four times and emerge at nearly the same angle, but in the opposite direction. This effect is illustrated by the 10-degree light ray. An observer looking at the lou-

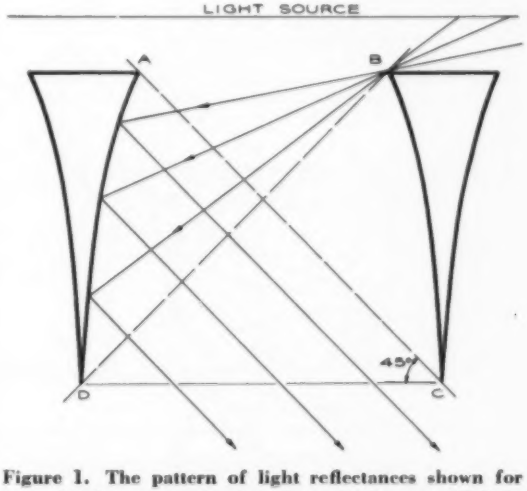


Figure 1. The pattern of light reflectances shown for several light rays originating above the louver. All light from the light source that strikes the louvers is reflected at an angle equal to or greater than the shielding angle. Thus, louver brightness in the shielded zone is independent of the size or brightness of the light source.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. AUTHORS: Large Lamp Department, General Electric Co., Cleveland, Ohio. A Transaction of the I.E.S.

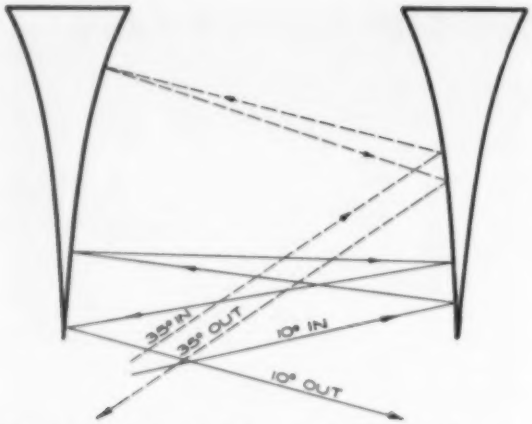


Figure 2. Pattern of light reflections shown for two light rays originating below the louvers. It can be seen that louver brightness in the shielded zone depends upon the brightness of the room surfaces.

vers would see reflected in them primarily the room surfaces on the observer side of the louver, but at the very low angles he may also see room surfaces on the opposite side.

Good lighting efficiency is provided by this design since all light entering from above the louvers comes out either directly or by a single reflection. In addition, this light is directed below the shielding angle, thus improving the utilization of the light.

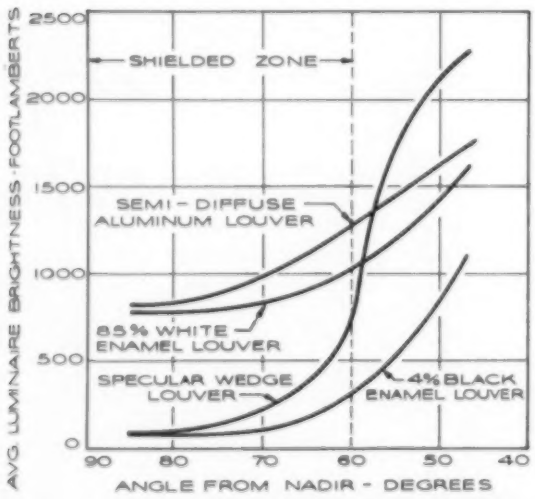
Brightness Comparisons

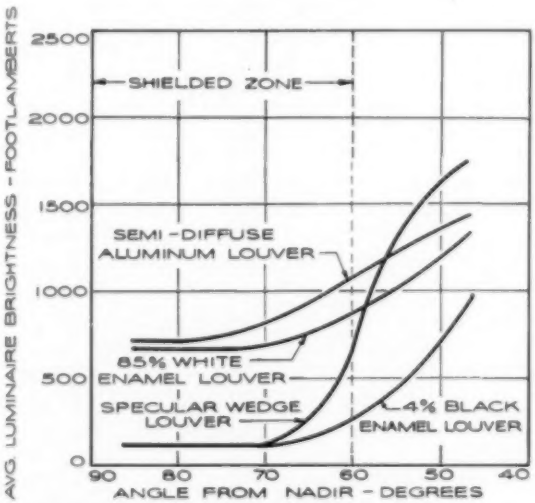
To obtain quantitative values of brightness and of lighting efficiency, actual louvers utilizing the parabolic wedge principle were designed and built. These louvering devices were given complete photometric tests and compared to various other types of brightness control media.

A 30-degree specular wedge louver was made and tested in both aluminum and white enamel luminaires. The luminaires tested were semi-direct for two 4-foot T17, non-circular cross-section lamps and are typical of present industrial types. In Fig. 3 average luminaire brightness (parallel to lamps) is plotted versus angle from nadir for the specular wedge louver and for several other types in the white enamel luminaire. All louvers provide the same 30-degree lengthwise shielding. The wedge louver provides brightness control similar to the black (four per cent reflectance) louver and is much lower in brightness than either the white enamel or the semi-diffuse aluminum louvers. The same louvers are compared in the aluminum fixture, and these data are shown in Fig. 4. Generally, the louver types maintained the same relative degree of brightness control as in the white enamel fixture.

In these industrial luminaires the wedge louver controlled only the lengthwise brightness and the reflector controlled the crosswise brightness. The parabolic wedge principle may also be applied in a grid pattern with various shaped cells[2] for multi-directional control.

Additional tests were made using a parabolic wedge grid with two- by two-inch square cells and





Figures 3 (left) and 4. Average luminaire brightness versus angle from nadir for the specular wedge louvers and other louver types in a white enamel (Fig. 3) and an aluminum (Fig. 4) luminaire. Both luminaires are semi-direct industrial types for two 4-foot T17 110-watt, non-circular cross-section lamps. All louvers provide 30-degree lengthwise shielding.

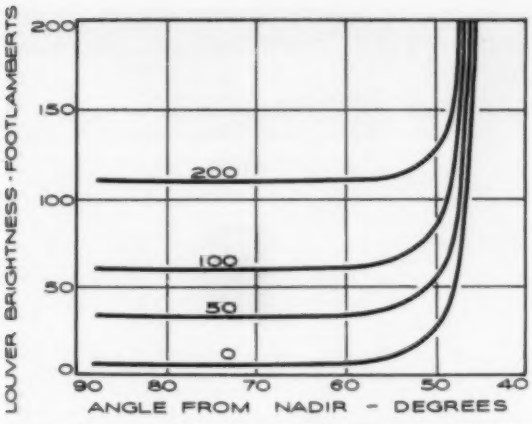


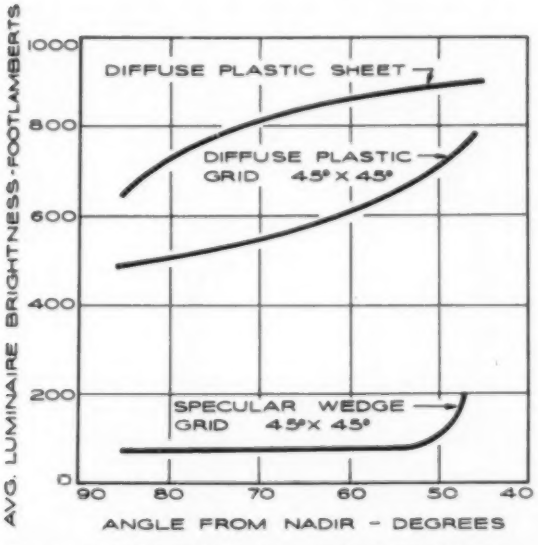
Figure 5. Variations of louver brightness versus angle from nadir plotted for several room surface brightnesses. Louver is a 45- by 45-degree specular wedge grid with two-inch square cells.

45- by 45-degree shielding. This grid was carefully cast in metal and given a coating of vaporized aluminum for the reflecting surfaces.

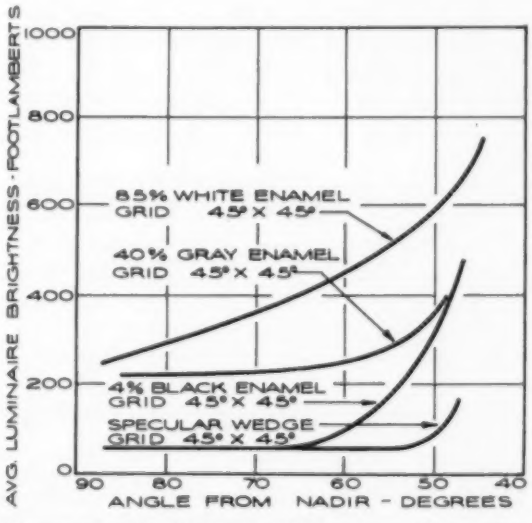
A series of tests was conducted using this wedge grid to determine the effect that room brightness may have on louver brightness. The results of these tests are indicated in the set of curves shown in Fig. 5. Louver brightness versus angle from nadir is plotted for several values of room surface brightness. For example, in a room with uniform surface brightnesses of 200 footlamberts the louver brightness is 110 footlamberts between 60 degrees and 85 degrees. The sharp increase in louver brightness below 55 degrees is due to diffuse reflections of the light source, since this experimental louver is not perfectly smooth.

The bottom (0) curve is based on the louver brightness encountered in a completely black room. The brightnesses indicated are due entirely to reflected brightnesses of the light source. The other curves, however, include brightnesses due to reflections of room surfaces and the relatively small amount contributed by the light source itself.

Figs. 6, 7 and 8 compare the brightness of the specular wedge grid with other types of diffusing and louvering media. All louvers have 45- by 45-degree shielding. Average luminaire brightness is plotted versus angle from nadir. The brightness of the luminaire was adjusted to correspond to that which would provide 500 footcandles in a 2.0(E) room with 50 per cent wall reflectance and 10 per cent floor reflectance. In Fig. 6 the specular wedge grid is compared with a diffuse plastic sheet and a diffuse plastic grid. The wedge grid is well below the brightness of either of these two materials. In Fig. 7 the comparison is made with ½- by ½-inch metal grids having reflectances of 85 per cent white, 40 per cent gray, and four per cent black. Both the black grid and the wedge grid are comparable in brightness between 60 degrees and 85 degrees, but between 47 degrees and 60 degrees the wedge grid is substantially lower. Although the white and gray enamelled grids are quite low in brightness compared with many other louvers, they



Figures 6 (left) and 7. Average luminaire brightness versus angle from nadir for various control media. Brightness is adjusted to correspond to that which will be obtained at 500 footcandles in a 2.0 (E) room with 50 percent wall reflectance and 10 per cent floor reflectance. The luminaire is a large area element with louvers or diffusing media mounted below the lamps. All louvers have 45- by 45-degree shielding.



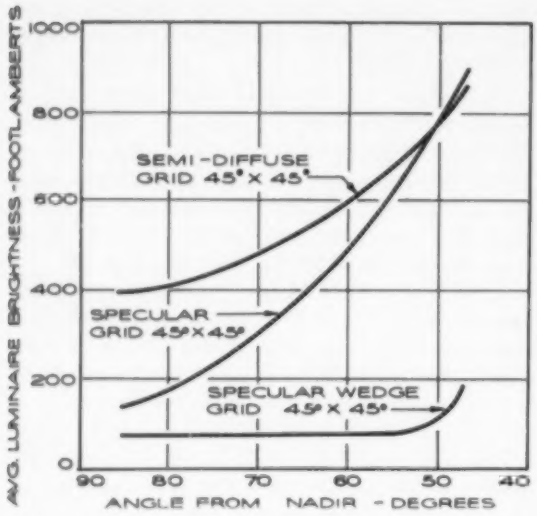


Figure 8. Average luminaire brightness versus angle from nadir for semi-diffuse grid, specular grid and specular wedge grid. Brightness is adjusted to correspond to that which will be obtained at 500 footcandles in a 2.0 (E) room with 50 per cent wall reflectance and 10 per cent floor reflectance. Luminaire is a large area element with louvers mounted below the lamps. All louvers have 45- by 45-degree shielding.

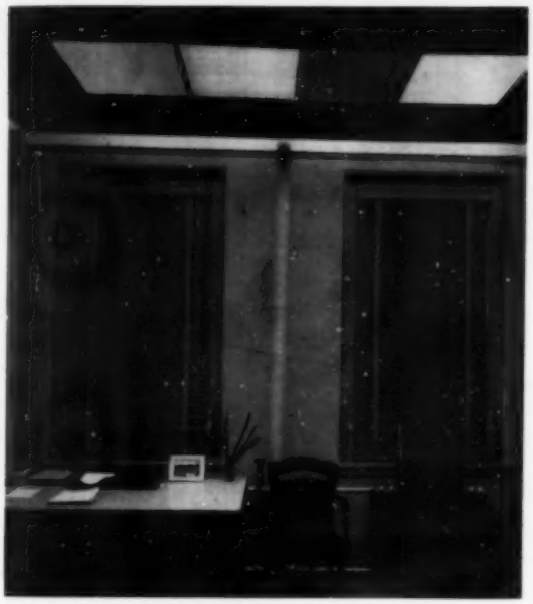
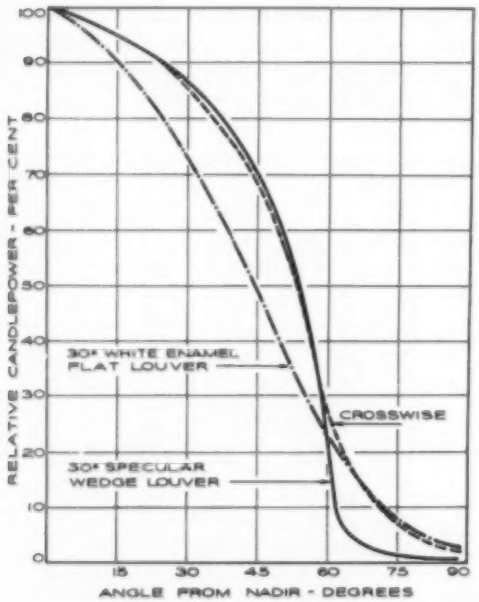
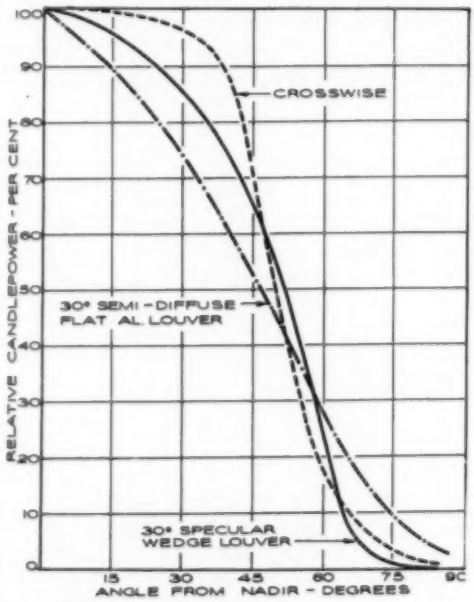


Figure 9. In this office the low brightness of the specular wedge grids are a striking contrast to that of the four louver grids which they surround. From left to right: white enamelled steel, semi-diffuse aluminum, gray enamelled steel and white translucent plastic. All louvers have 45- by 45-degree shielding.





Figures 10 (left) and 11. A more concentrated lengthwise candlepower distribution is obtained with the specular wedge louver than with conventional louvers in either enamelled (Fig. 10) or aluminum (Fig. 11) luminaires. The luminaires are semi-direct industrial types for two 4-foot T17 110-watt, non-circular cross-section lamps. Zero degree candlepower is adjusted to 100 per cent for each curve. In each luminaire the crosswise distribution is the same for either louver type.

TABLE I — Design Data — Industrial Type Luminaires.

Luminaire Type*	Shielding (Degrees) C	L	Flux[3] Ratio	Efficiency (Per Cent) Down	Up	Total	Coefficient of Utilization 5.0(A) (1)	(2)	2.0(E) (1)	(2)	0.8(I) (1)	(2)	Lengthwise Average Luminaire Brightness (fL) Angle from Nadir 60°	70°	80°
1. White Enamel Refl. No Louver	25	0	.38	72	17	89	79	73	66	58	42	35	.....	.....	.....
2. Aluminum Reflector No Louver	35	0	.42	61	16	77	67	62	58	52	38	33	.....	.....	.....
3. White Enamel Refl. 85% White Enamel Louver	25	30	.44	61	20	81	67	62	57	51	38	32	1040	820	800
4. Aluminum Reflector 85% White Enamel Louver	35	30	.45	54	16	70	60	55	51	46	34	29	870	680	660
5. White Enamel Refl. Aluminum Louver	25	30	.43	58	18	76	64	59	54	48	36	30	1270	980	840
6. Aluminum Reflector Aluminum Louver	35	30	.45	53	15	68	58	54	50	45	33	28	1070	820	720
7. White Enamel Refl. 4% Black Enamel Louver	25	30	.49	45	17	62	52	47	45	40	31	26	310	120	100
8. Aluminum Reflector 4% Black Enamel Louver	35	30	.50	42	14	56	48	44	42	37	29	25	240	120	120
9. White Enamel Reflector Specular Wedge Louver	25	30	.45	63	18	81	70	65	60	54	40	34	810	170	120
10. Aluminum Reflector Specular Wedge Louver	35	30	.47	52	16	68	59	54	51	46	34	29	630	120	120

*48-inch luminaires for two T17 110-watt non-circular cross-section lamps with grooves oriented horizontally.
(1) Room reflectances: 70 per cent ceiling, 50 per cent walls, 10 per cent floor.
(2) Room reflectances: 50 per cent ceiling, 30 per cent walls, 10 per cent floor.

are still much brighter than the wedge grid. In Fig. 8 the comparison is made with a semi-diffuse grid and a specular grid. In both comparisons the wedge grid is much lower in brightness.

Some of these brightness comparisons can be shown visually in Fig. 9. The lighting system installed in this office provides 200 footcandles and utilizes two-foot-square specular wedge grid sections with 45- by 45-degree shielding and with ½- by ½-inch cell size. For comparison, four other grids were added to the ceiling and obviously are much higher in brightness. These materials all have the same shielding angle and the same cell size; however, the brightness differences are due to differences in the brightness control properties of the semi-diffuse aluminum, white enamelled steel, gray enamelled steel and white translucent plastic.

Lighting Efficiency

Data shown in Figs. 3 through 8 have indicated the effectiveness of this louver design in controlling brightness. However, for this design principle to have practical application, good lighting efficiency is also required. One of the measures of lighting efficiency is a candlepower distribution that is effective in directing light to the work surface.

In Fig. 10 candlepower distributions are shown for the white enamel industrial luminaire in the crosswise plane; and lengthwise plane comparing the white enamel and the specular wedge louvers. With the wedge louver, it is possible to obtain a more concentrated distribution, since most of the light normally emitted at the higher angles is redirected into the non-shielded zone (between 0 and 60 degrees).

TABLE II — Design Data — Large Area Luminaires.

Luminaire Type*	Shielding (Degrees) C	L	Flux Ratio[3]	Efficiency (Per Cent)	Coefficient of Utilization 5.0(A) (1)	(2)	2.0(E) (1)	(2)	0.8(I) (1)	(2)	Average** Luminaire Brightness (fL) Angle from Nadir 50°	60°	70°	80°
1. Diffuse Plastic Sheet	....	....	.35	65	62	59	52	47	34	28	890	860	820	730
2. Diffuse Plastic Grid ½" Cell	45	45	.44	52	52	50	45	41	31	27	700	600	540	500
3. Configurated Clear Plastic	....	....	.45	57	56	54	48	45	34	29	750	450	330	320
4. 85% White Enamel Grid ½" Cell	45	45	.49	43	41	39	36	33	26	22	590	450	350	290
5. 40% Gray Enamel Grid ½" Cell	45	45	.57	25	24	23	22	21	16	15	370	250	230	220
6. 4% Black Enamel Grid ½" Cell	45	45	.63	20	20	19	18	18	15	13	310	90	80	80
7. Semi-Diffuse Aluminum Grid ¼" Cell	45	45	.43	58	57	54	49	45	34	29	790	600	480	410
8. Semi1Diffuse Aluminum Grid ¼" Cell	60	60	.46	45	45	43	39	36	27	24	740	570	460	390
9. Specular Aluminum Grid ½" Cell	45	45	.47	41	38	37	34	31	24	21	790	490	300	180
10. Specular Wedge Grid 2" Cell	45	45	.61	43	44	42	40	38	31	28	80	60	60	60

*Tested in a two- by four-foot panel with a cavity efficiency of 83 per cent.
**Based on 500 footcandles average maintained in service.
(1) Room reflectances: 70 per cent ceiling, 50 per cent walls, 10 per cent floor.
(2) Room reflectances: 50 per cent ceiling, 30 per cent walls, 10 per cent floor.

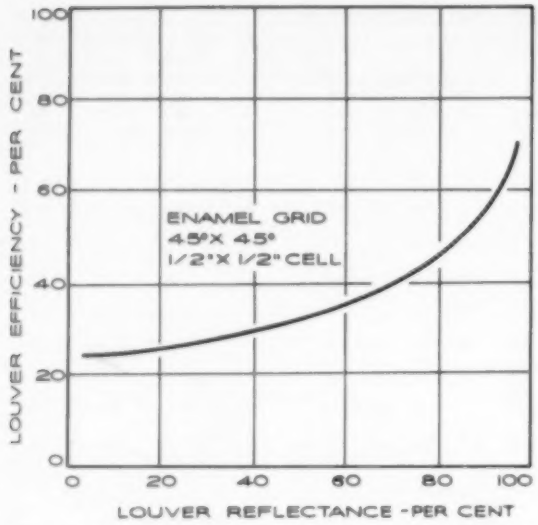


Figure 12. Relationship between louver reflectance and louver efficiency for a 45- by 45-degree grid louver below an enclosed cavity. Efficiency for a 45- by 45-degree specular wedge grid below the same cavity is equal to that of the 85 per cent reflectance white enamel grid.

In Fig. 11 similar comparisons are made in an aluminum industrial type luminaire. In this luminaire the experimental wedge louver provides a more concentrated distribution than the flat aluminum louver and is similar to the distribution obtained in the crosswise plane. This more concentrated candlepower distribution results in a higher flux ratio,[3] as indicated in Table I.

A black enamelled louver in both reflectors provides the highest flux ratio, but with considerable sacrifice in luminaire efficiency. However, the efficiency with the wedge louver compares favorably with conventional louver types, but with brightness control comparable with the black louver. The net result is that the reduction in brightness, as shown in the last column of Table I, is obtained with no sacrifice in lighting efficiency.

Similar comparisons of flux ratio, efficiency, and coefficients of utilization are made in Table II for various control media in large area luminaires. The specular wedge grid is comparable in lighting efficiency with all other systems for the small rooms because of its more concentrated distribution. In the larger rooms several other luminaire types have somewhat greater lighting efficiency. However, in these larger areas greater consideration must be given to brightness control to obtain adequate visual comfort particularly at lighting levels of 200 footcandles and above. In the last column are shown the average luminaire brightnesses for several angles in a medium sized room lighted to 500 footcandles. The wedge grid brightness is typically one-fifth to one-tenth the brightness of the other types compared.

As indicated by the gray and black enamel grids, brightness control can be obtained by reducing louver reflectance. However, this results in a great sacrifice in lighting efficiency. The relationship of louver reflectance to louver efficiency is shown in Fig. 12 for a 45- by 45-degree grid. Since the specular wedge grid has an efficiency comparable with an 85 per cent reflectance white enamel grid and brightness control comparable with a four per cent black enamel grid, there is little to be gained by reducing the enamelled grid reflectance below that of a good white finish.

Lighting Design Data

The parabolic wedge louver design principle provides us with a new tool to design general lighting systems at any lighting level with aceptable luminaire brightness. In Table III design information is shown to provide 1000 footcandles in a medium sized room. These data indicate that the only system tested that combines good lighting efficiency and low luminaire brightness is the specular wedge grid. In fact, even at 1000 footcandles the luminaire brightness is well below the BCD[4] region, and visual comfort must be judged more by pleasantness of environment rather than discomfort evaluations. If higher brightnesses are preferred, they may be

TABLE III — Design Data — Large Area Luminaires. 1000 Footcandles Average Maintained in Service; 2.0 (E) Room Ratio, 50 Per cent Walls; 10 Per Cent Floor Reflectances.

Lighting System	Lamp Type	Lamp Spacing Inches	Average Luminaire Brightness (fL) Angle from Nadir—Degrees 50°	60°	70°	80°	Watts Per Square Foot
1. Diffuse Plastic Sheet	F96PG17/CW	8.2	1780	1720	1640	1460	45.5
2. Diffuse Plastic Grid 45° x 45°	F96PG17/CW	7.1	1400	1200	1080	1000	52.5
3. Configurated Clear Plastic	F96PG17/CW	7.6	1500	900	660	610	49
4. 85% White Enamel Grid 45° x 45°	F96PG17/CW	5.7	1180	900	700	580	65.5
5. 40% Gray Enamel Grid 45° x 45°	F96PG17/CW	4.0	740	500	460	440	93
6. 4% Black Enamel Grid 45° x 45°	F96PG17/CW	2.8	620	180	160	160	133
7. Semi-Diffuse Aluminum Grid 45° x 45°	F96PG17/CW	7.7	1580	1200	960	820	48.5
8. Semi-diffuse Aluminum Grid 60° x 60°	F96PG17/CW	6.1	1480	1140	920	780	61
9. Specular Aluminum Grid 45° x 45°	F96PG17/CW	5.4	1580	980	600	360	68
10. Specular Wedge Grid 45° x 45°	F96PG17/CW	6.3	160	120	120	120	58

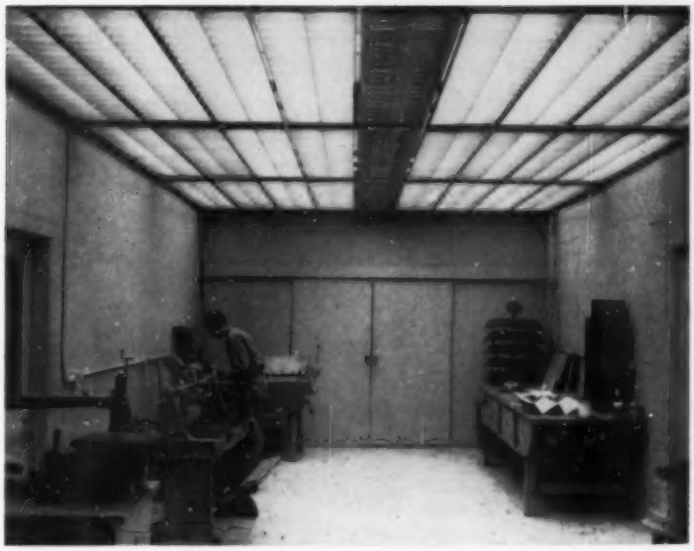


Figure 13. Variations in the brightness of wedge louvers can be obtained by changes in louver finish, contour or both. In this installation the center row of wedge louvers are specular aluminum; the others are semi-diffuse aluminum.

obtained by variations in louver contour or finish, or both.

The effect of variation in louver finish is illustrated in Fig. 13. This shop area is lighted to a level of 1000 footcandles using aluminum luminaires with wedge louvers. The lower brightness of the center row of luminaires is due to the use of specular aluminum rather than the semi-diffuse aluminum used for the others.

Conclusions

The parabolic wedge louver design principle makes possible lighting systems at any lighting level with acceptable luminaire brightness in the shielded zone. In addition, this brightness control can be accomplished with good lighting efficiency.

This brightness control concept can be applied in several different ways in addition to the ones already mentioned. It can be utilized in the design of reflectors for incandescent and mercury lamps as well as for fluorescent lamps. It can also be used for reflector or louver attachments to improve the comfort of existing lighting systems. The application of this design principle could lead to a wide variety of luminaire designs for general and supplementary lighting.

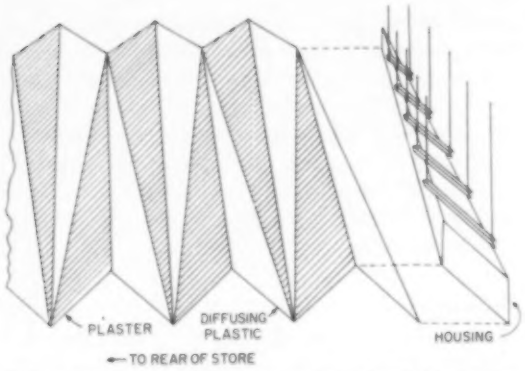
References

1. *IES Lighting Handbook*, Third Edition, Illuminating Engineering Society, 1959.
2. *Magazine of Light*, Vol. 27, No. 3, p. 9 (1958).
3. Potter, W. M., and Russell, A. H.: "Measured Utilization Factors II," ILLUMINATING ENGINEERING, Vol. L, No. 4, p. 180 (April 1955).
4. Luckiesh, Matthew, and Guth, S. K.: "Brightness in Visual Field at Borderline Between Comfort and Discomfort (BCD)," ILLUMINATING ENGINEERING, Vol. XLIV, No. 11, p. 650 (November 1949).

Watch for November IE

Top lighting installations of 1959, national winners of the My Most Interesting Lighting Job Contest, in both commercial and residential sections, will be featured in the November issue of ILLUMINATING ENGINEERING.

Looking from front to rear of Nunn-Bush Shoe Store.



Ceiling perspective from above, at Nunn-Bush Shoe Store.

View of luminous panels from rear of shoe store.

Custom-Made Lighting For Customer Appeal

Shoe Store with Ceiling Interest

Custom-designed, the lighting system at Nunn-Bush Shoe Store in Miami, Fla., consists of what has been described by the designer as "a series of reversing horizontal split pyramids, appearing as reversing undulating triangular planes."

The problem was one of designing and constructing eleven 15-foot long recessed units (six lefts and five rights) whose apparent faces are triangular. The longest side of each triangle is installed parallel to the floor, with the two shorter sides rising to a point 30 inches higher. Housing walls must remain vertical, because the fine points of each "right" housing rest against the more open point of the "left" housing which follows it.

Housings, less luminaires, were mounted on angle iron supports and C-channel and wire lath was installed between the units to make the whole rigid. Plaster and paint were then applied to the sides facing the front of the store. The plenum was painted a flat white and two-lamp fluorescent channel was installed, using T12 lamps. The frosted ribbed acrylic plastic diffusers were die-cut and inserted in the sides facing the rear of the store.

General illumination level after two months was 115 to 120 footcandles.

This installation won third prize in the Southeast Florida Section's 1958 contest for My Most Interesting Lighting Job, for Robert H. Manley, Partner, Studio of Lighting, Miami, Fla.; Architect, Robert M. Little, AIA.

Luxury Lighting For Luxury Imports

Fine imported Danish merchandise is displayed and sold at S. Christian of Copenhagen, in Burlingame, Calif., and all efforts were made to show it at its best. Store fixtures and mezzanine paneling are of a light beige teak imported from Denmark, and the wall-to-wall carpeting is also a light beige. Walls are light blue.

In the re-lighting and re-modeling of the 50- by 200-foot main floor area, an existing arched sky-

In the August 1959 issue of IE were shown 15 store lighting installations meeting or surpassing the new IES recommended levels of illumination. Good engineering jobs all, they made use of various combinations of standard manufacturers' fixtures. The two installations shown here, while using some conventional equipment, also make use of custom-designed units to give each store its own unique personality.

Nighttime view of S. Christian of Copenhagen, showing custom-designed fixture over jewelry display.

light, running almost the length of the store, was retained, but covered, at the 20-foot ceiling height by 2-foot-square plastic coffers. These add additional diffusion of the daylight and reduce brightness contrasts. Flanking this skylight, two continuous rows of 4-lamp slimline fluorescent units, with 2- by 8-foot plastic diffusers, add to the general lighting in the central merchandising area.

Special display lighting for showcases in this central area is of two types, custom-designed to the merchandise being shown. A suspended unit is mounted over the jewelry case at the front of the store, with 20 perforated bronze drums furnishing incandescent accent lighting over the entire case. Another custom treatment is on three displays of fine glassware which are shown to advantage in cases with base lighting from luminous fluorescent panels. The center one of the three has further interest appeal, with a wrought-iron structure connecting it to a square mirror installed in the luminous ceiling above the case.

General lighting under the mezzanine is supplied by 52 adjustable semi-recessed floods interspersed with 2-foot-square 4-lamp 20-watt fluorescent units with plastic diffusers. Adjustable bullet-type reflector floods, with louvers, are ceiling mounted in a continuous track. This permits flexibility in highlighting merchandise on the wall shelves—for the most part, china, metal-ware and figurines. Continuous plug strip is installed at the base of all walls for displaying portable lamps.

Mezzanine lighting is by the same type square 4-lamp 20-watt fixtures that are used under the mezzanine.

Illumination levels throughout the store range from 100 to 200 footcandles.

This installation was the entry of M. O. Bunker, Pacific Gas and Electric Co., San Mateo, Calif., in the Golden Gate Section's 1958 contest for My Most Interesting Lighting Job.

Daytime view of S. Christian of Copenhagen, with skylight adding to general illumination. Showcases for glassware in the foreground are highlighted from below.

Application Possibilities of

Wide Range Dimming Of Fluorescent Lamps

By PHILIP E. MASSIE
ALLEN B. ROSENSTEIN

THIS DISCUSSION will be narrative rather than technical, since much of the field has been the subject of only qualitative discussion with little quantitative analysis.

Dimming of fluorescent lamps has been practiced with varying degrees of success for about ten years. Commercial dimming systems are generally based on the use of the 40-watt T12 lamp using the rapid-start principle. Commonly used dimmers attained ratios varying between 40 and 100 to 1 until recent developments increased these ratios. Flicker was very often present at reduced lighting levels. The requirement for dimming of lamps other than the F40T12 arose in the aircraft industry. After initial tests, it was evident that dimming ratios much greater than 100 to 1 were desirable. A development program was initiated on this basis and suitable dimming ballasts were developed. The extension of this development to the commercial industrial field is proceeding very slowly.

Aircraft Fluorescent Lighting

The present generation of turbine-powered transport aircraft makes fluorescent lighting practical for the first time in aircraft history. Previous aircraft have been limited in the use of fluorescent lamps, since the primary power system was 28-volt, direct current. To supply the alternating current power required for best fluorescent lamp operation, airborne rotary inverters were required. This imposed two penalties. The conversion efficiency of these inverters is in the order of 50 per cent. With the aircraft already power-limited electrically, efficiency is a critical item. Second, the inverters have a nominal weight of 30 pounds per kilowatt. Weight is a critical factor in aircraft. Designers are authorized to expend amounts varying from $30 to $100 per pound to remove weight from the aircraft.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. AUTHORS: Day-Ray Products, Inc., South Pasadena, Calif. and University of California, Los Angeles, Calif.

The aircraft of the new generation are equipped with primary electrical power sources supplying 115/200 volts alternating current, generally at a constant frequency of 400 cycles.[1] This is a practical power source for the operation of fluorescent lamps. Existing techniques in ballast design are applicable.

Several advantages accrue with the use of fluorescent lamps in aircraft. These include: Increased lamp life by a factor of 10, reduced power consumption by a factor of 3, increased vibration resistance, reduced heat rejection and reduced sensitivity to line voltage variation.[2] In addition, the interior lighting designer has an improved tool for area lighting problems.

Variation of light level with fluorescent lights became desirable in connection with studies on high intensity lighting of the cockpit instrument panel.[2,3] Continuous and uniform light level variation can best be accomplished by continuous and uniform dimming of the lights. This was made possible by development of new types of dimming ballasts.[4,5] With the availability of these ballasts, dimming was extended to the passenger cabin. This provides for light control to assist in the crowd handling problem that exists in the cabin.

In addition to the continuous dimming installations, a requirement for two-level lighting exists. This was originally developed for lavatory lighting. The intent was to minimize the "blast" effect caused by opening the door of the brightly-lighted lavatory at night when the aircraft was relatively dark. By using a two-level lighting system connected to a door switch, the lavatory light level is reduced when the door is opened. This provides transition light level and reduces passenger annoyance. The use of two-level lighting has been extended to other areas, particularly the galley.

The space problem is always critical on aircraft. This dictates that two dimensions of any installed equipment should be held to a practical minimum.

For this reason, the 5/8-inch diameter fluorescent lamps were selected. The fluorescent lamp starter is always a maintenance problem in a vibration environment. Since existing T5 lamps were of the pre-heat type, a new line of lamps was developed for rapid start operation to eliminate the starter problem. Cathode heating is a requirement for dimming of hot cathode lamps, so the rapid-start lamp is better adapted to dimming operation. The necessary lamp development was undertaken by commercial lamp manufacturers.

General Considerations for Dimming Range

The required variation in light level for a change in occupant task has not been critically evaluated. Research on quantity of light in aircraft cockpits has been centered on the problems of extreme low light level operation, generally using red light for low brightness discrimination. Studies in commercial, industrial and residential lighting have been related to high levels of light for maximum task performance. This is exemplified by the new recommended light levels published by IES. The transition and intermediate problems have not been attacked.

The aircraft lighting designers approached the problem on a cut-and-try-basis. Historically, the approach to aircraft lighting has been largely a matter of available equipment, luminaires and lamps which could be installed in the spaces allotted for lighting installations. High and low light levels were very loosely specified and mock-ups were used to prove out the instalaltion. The cockpit received slightly more critical attention. Lighting installations were usually assigned to some electrical engineer who had made a previous lighting installation and could read a simple form of light meter. With this approach to lighting design, eye response factors to variation of light level were largely overlooked.

The new generation of aircraft has received more critical evaluation and design. Attempts have been made to specify light levels to enable performance of the required tasks. In tests to prove required illumination, it became evident that low light levels shoul be less than the initial specifications. Eye response factors to variation in light level were examined and evaluated. This was found to be an important factor in specifying dimming range. Evaluation of the mock-up is still the final proof of the lighting installation.

The theatre experience provides a good example of eye response to low light level. This also gives a clue to the dimming ranges required. The eye responds, roughly, to orders of magnitude in light level changes.[6] This is roughly a logarithmic function and many refer to eye response as logarithmic. What does this mean? It means that the eye sees the same effect in a change of light level from 100 to 10 as it does in a change from 10 to 1. Inverting this, the dimming ratio has the same appearance from 1 to 10 as from 10 to 100. The aircraft problem showed that if you happened to blink as the light level changed, a 50 per cent reduction in light level was hardly perceptible by visual observation.

The number of orders of magnitude required of an installation may be roughly analyzed by comparing the recommended light level in a theatre during the picture with the level at a terminal ticket counter.[7,8] This change in light level from 0.1 footcandle to 100 footcandles is a change of three orders of magnitude, or 1000 to 1. Compare this to the tasks present in an aircraft passenger cabin.

Disregarding maintenance and preparation, the first task is to load and seat 100 or more people in a confined area with limited traffic space. Purses, coats and magazines must be stowed. On some airlines, the stewardess must "lift the transportation" of each individual. Since time spent on the ground is non-revenue producing, it is desirable to load as rapidly as possible. The loading task can be expedited by use of high light levels. Assuming a meal is served enroute, this is expedited with a high illumination level.

The "enroute" portion of the flight may take place during normal sleeping hours. This requires reduction of the over-all light level to something in the vicinity of the theater level or less. The unloading task again requires high level lighting. This points toward lamp dimming of at least three orders of magnitude. Some ballast units in use for aircraft installation are well into the fourth order. Aircraft lighting designers are still asking for more.

What is the penalty for insufficient dimming range? The sleeping situation in the aircraft cabin still requires sufficient light to permit limited circulation in confined aisles. If the primary lighting system cannot dim to a sufficiently low level, a second lighting installation must be added for the nighttime condition. This adds weight and weight is critical in aircraft.

The dimming requirement in the cockpit is equally stringent. The crew must operate in lighting environments that are beyond the comprehension of the earth-bound lighting designer.[2] One extreme is the high altitude daylight environment with an ambient level approaching 12,000 footcandles with a non-reflective background.[9,10] The other extreme is the night operational condition where minimum light is required in the cockpit area. A third condition is that of landing into the sun. The

upper half of the surround may have a brightness of 1000 to 3000 footlamberts. The task area is on the margin of this bright field and may have a brightness of 10 to 100 footlamberts. The contrast between the task area and the lower portion of the surround may approach zero. The crew is engaged in accomplishing a "controlled crash" at speeds in excess of 140 miles per hour with a five million dollar machine and 100 people as the stakes in the game. Add to this the different temperament of individuals and the decrement in visual acuity with increase in age, and this constitutes the problem requiring variation of light level in the cockpit.

Single-Level Applications

Before leaving the aircraft problem, a few words on single-level operation of fluorescent lamps. The applications of single-level lighting are many and varied. A specific case is the use of the 4-watt T5 aircraft fluorescent lamp as a passenger reading light. The requirement was to vary location of the seats for different class configurations. With all the passenger accessories installed in the seat, the problem was much simplified. Installation of a reading light inside the upholstery of the seat presented a problem in heat dissipation. This was mitigated by use of a fluorescent lamp with the reduced heat rejection noted above. The fluorescent starter maintenance problem, noted above, made the rapid-start ballast a necesity. The final approach was to design a typical shunted autotransformer rapid-start ballast. Power factor correction was omitted as a weight saving item. Since the power system has a frequency of 400 cycles, the size and weight of the ballast is greatly reduced. The big problem was just how far could size and weigh be reduced. There are several answers to this, depending on the ballast manufacturer. One form of this ballast has a weight of 0.19 pounds.

Techniques of Fluorescent Dimming

As noted above, all dimming circuits for hot cathode fluorescent lamps are based on continuous cathode heating. To assure satisfactory starting in high humidity environments, the lamps should be coated with a moisture resistant coating. Since the cathode current no longer has to be coordinated with lamp arc stream current, the cathodes can be designed for maximum life, highest efficiency and vibration resistance. These factors describe the rapid-start lamp. Dimming is not restricted to rapid-start lamps. Pre -heat lamps can be dimmed if the humidity is low or if the lamps are coated for moisture resistance.

There are several specific approaches to fluorescent dimming but they all fall in two general categories: voltage control and current control. Voltage control is typified by many of the commercial 60-cycle dimming systems of the past and present. With the use of some form of starting device for low rms voltage operation of the lamp, these systems work quite well. They generally have a tendency to flicker at lower light levels. Usually, increase of the voltage above the low operational point is required to get the lamp started. Aircraft dimming of fluorescent lamps is being accomplished by voltage control.[5]

Current-control dimming of fluorescent lamps is exemplified in commercial practice by the thyratron dimming system. This provides very wide ranges of light variation. Weight, cost and maintenance did not commend this approach to aircraft use. Current control by use of series saturable reactors in the lamp circuit has provided a system with the wide dimming range and low maintenance characteristics desired.[4] The current-control systems are expensive in relation to single-level systems and are somewhat higher priced than voltage-control systems. They provide the desired wide-range and flicker-free dimming. Since flicker is based on the incremental impedance of the lamp, the ballast impedance must be matched to the lamp.[4] For the high incremental impedance lamps, current control is the most desirable dimming method. This permits dimming any of the hot cathode lamps. Investigation shows the T5 lamp, used in aircraft, to be the most difficult lamp to dim without flicker, due to the high incremental impedance.

The current-control ballast systems also provide the ability to dim large installations from a single control. Since there is appreciable power gain in these systems, the control size is reduced. Existing aircraft ballasts show a power gain of about 4. This can be varied by the ballast design. The saturable reactor ballasts are controlled by standard variable auto-transformers.

Present ballast designs cover lamps from the 160 milliampere T5 lamps to the 800 milliampere T12 lamps on 60 and 400 cycles. It is not anticipated that the 1500 milliampere lamps will present any problems in dimming. Studies on 1600-cycle dimming systems are in progress. This development was initiated in connection with lighting requirements for manned orbital vehicles having direct current power supplies.[11]

Fluorescent Dimming Applications

Wide-range fluorescent dimming is applicable in most installations where dimming of incandescent lamps is presently used. Auditorium and theatre lighting are examples. These are crowd-handling problems similar to the aircraft loading situation.

The use of fluorescent dimming will enable us to make use of the increased lamp life and efficiency typical of single level fluorescent lighting.

There are other possibiilties for dimming installations. A case history concerns the use of dimming in a restaurant. The maitre d' used the light level to assist in handling the patrons. When the dining room was crowded and there was a waiting line, the light level was turned up. This induced the diners to eat and get out to make room for others. When the dining room was not crowded, the light level was turned down. This caused the diners to linger for an extra drink or cup of coffee, all added to the bil', increasing the return.

It is possible to use a dimming installation to equalize the light level where daylight enters from one side of the room. Placing a dimming control on the lights furthest from the daylight source will permit equalization of the illumination. Dimming can also be used to maintain illumination with change in daylight. Minimum artificial light is used on bright days to economize on power. As daylight is reduced, artificial light can be increased to maintain the desired light level. This type of installation is applicable for all work areas and can assist in maintaining a high performance rate.

A psychological factor enters here. Some years back, an experiment was instituted to determine the maximum amount of light at which an increase in light level did not increase performance. A factory area was selected and the light level was increased. Performance increased as a result. A second and subsequent increases in light level brought increases in performance. Then a check on results was attempted by decreasing the light level. Performance increased again. The factor here is that employees were conscious of the fact that management was trying to do something to increase output so they increased the output. Control of the lighting situation can be a visible evidence to the working force that management has an interest in their environment.

Light level control can be made a part of the home lighting environment. Basically, a reduced light level will contribute to relaxation while a high light level is required for activity. Use of a dimming installation permits something more than the on-off conditions now in existence. Where rooms must serve a multiplicity of purposes, dimming is desirable. The same light distribution can be retained for reading or other activity as for viewing television. Only the level is reduced.

For all of these applications, wide-range fluorescent dimming provides one solution. It permits the low heat rejection, uniform area illumination, high efficiency and long lamp life typical of fluorescent lighting.

References

1. Duyan, Peter: "Twenty-Five Years of Progress in Aircraft Electrical Systems," *Electrical Engineering*, Vol. 78, No. 5, p. 527 (May 1959).
2. Massie, P. E.: "Lighting the Modern Commercial Aircraft," Paper 57-458, *Transactions of the American Institute of Electrical Engineers* (September 1958).
3. Massie, P. E.: "High Altitude Cockpit Lighting," National Aircraft Lighting Conference, Illuminating Engineering Society (May 1958).
4. Massie, P. E.: "Series Saturable Reactor as a Fluorescent Lamp Dimming Ballast," Conference Paper 59-787, Air Transportation Conference, American Institute of Electrical Engineers (June 1959).
5. Banios, E. W.: "Development of a Dimmable Aircraft Fluorescent Light System," Conference Paper, Air Transportation Conference, American Institute of Electrical Engineers (June 1958).
6. "Levels of Illumination," *IES Lighting Handbook*, Second Edition, P. 9-68.
8 "New Footcandle Tables," ILLUMINATING ENGINEERING, Vol. LIII, No. 8, p. 430 (August 1958).
9. Tousey, Hulbert: "Brightness and Polarization of the Daylight Sky," *Journal of the Optical Society of America*, Vol. 37, p. 78 (February 1947).
10. Barr, N. L., et. al.: "Brightness of the Atmosphere," Research Report, Project NM 001, Bureau of Aeronautics Project Ted PTR AC223, Washington, D. C., Vol. II, p. 191 (March 1953).
11. Massie, P. E. and Rosenstein, A. B.: "Direct Current Fluorescent Lighting for Manned Orbital Vehicles," Conference Paper, Air Transportation Conference, American Institute of Electrical Engineers (June 1959).

January 30—Deadline for 1960 Conference Paper Outlines

The Papers Committee of IES has set January 30, 1960, as the deadline for submittal of outlines for proposed papers for the 1960 National Technical Conference. Outlines should be mailed to:

Floyd W. Sell, Chairman, IES Papers Committee
Detroit Edison Co.
2000 Second Ave.
Detroit 26, Mich.

Assessment of Color Rendition Under an Illuminant Using Color Tolerances for Natural Objects

By C. L. SANDERS

Consideration of the color rendering properties of illuminants and of the methods previously suggested for assessing them indicates the desirability of a more subjective assessment. This paper suggests a procedure which uses the color tolerance ellipses[1] obtained by subjective judgments of the color rendition of several natural objects.

Although the very nature of subjective judgments makes some of the steps uncertain, it seems worthwhile to outline a method for determining a color rendering rating which satisfies a general feeling about the relative merits of several illuminants. The color rendering properties of the test illuminants with the spectral energy distributions given in Table II are considered in detail. The natural objects with the spectral reflectances given in Table I are used as test samples and the chromaticity of these objects under the test illuminants are given in Table III. It will be noted that the chromaticity of the white sample in each case is located in one of two regions: "Daylight" type illuminants near CIE Illuminant *B*, and "Northlight" illuminants near CIE Illuminant *C*. Therefore, the two sets of color tolerance ellipses described in Reference 1 are applicable. Since the reasoning is parallel for each set, only the method used for the "Daylight" illuminants will be considered in detail in the following sections.

In order to arrive at a definite number to express the quality of color rendition by a light source, several gaps must be bridged by making arbitrary but reasonable assumptions.

Author: Division of Applied Physics, National Research Council of Canada, Ottawa, Ont. This study is part of a Ph.D. thesis submitted to the Imperial College, University of London, London, England, 1955.

Procedure

(a) *Allowance for Chromatic Adaptation*

The important effect of adaptation in the problem of color rendition has been illustrated by many papers.[2,3,4,5] Over a limited range of illuminant chromaticities the observer's eyes will adapt in such a way that a non-selective highly reflecting sample will appear white. The effect of this chromatic adaptation on the appearance of other chromaticities is significant and should be considered. It was suggested by Evans[3] that if one could find the spectral sensitivity of the three photosensitive receptors in the eye, one could then allow for adaptation by

TABLE I — Spectral Reflectance of Natural Objects Used in Calculating the Color Rendering Rating.

Wavelength mμ	Hand	Face	Tea	Butter	Beefsteak	Potato Chip	Wavelength mμ	Hand	Face	Tea	Butter	Beefsteak	Potato Chip
404.7	.114	.163	.031	.400	.017	.135	560	.215	.260	.130	.835	.047	.432
435.8	.121	.189	.050	.300	.025	.180	570	.213	.260	.136	.843	.046	.445
546.1	.218	.259	.119	.817	.035	.408	580	.210	.268	.142	.844	.032	.456
578.0	.210	.266	.142	.845	.034	.475	590	.251	.340	.149	.844	.062	.467
380	.115	.165	.020	.480	.017	.100	600	.306	.400	.155	.845	.164	.476
390	.115	.165	.025	.450	.017	.110	610	.350	.460	.164	.845	.227	.485
400	.115	.165	.030	.421	.017	.124	620	.391	.502	.173	.843	.266	.493
410	.112	.162	.036	.383	.017	.144	630	.417	.530	.182	.842	.296	.502
420	.111	.163	.041	.343	.018	.146	640	.430	.548	.190	.841	.315	.511
430	.115	.179	.047	.311	.022	.171	650	.438	.565	.198	.839	.333	.518
440	.128	.195	.054	.292	.028	.186	660	.447	.582	.207	.837	.348	.525
450	.157	.205	.063	.268	.035	.197	670	.452	.594	.214	.835	.365	.531
460	.182	.221	.072	.242	.043	.222	680	.457	.598	.218	.833	.377	.537
470	.200	.237	.078	.251	.052	.250	690	.458	.600	.218	.831	.385	.543
480	.215	.243	.084	.273	.061	.262	700	.460	.600	.218	.829	.393	.547
490	.225	.257	.090	.260	.068	.283	710	.462	.600	.218	.827	.398	.550
500	.232	.261	.096	.301	.072	.309	720	.464	.600	.218	.825	.402	.552
510	.227	.266	.100	.415	.070	.331	730	.465	.600	.218	.823	.406	.552
520	.214	.273	.104	.587	.063	.354	740	.465	.600	.218	.821	.407	.553
530	.209	.270	.110	.735	.048	.374	750	.465	.600	.218	.820	.408	.553
540	.215	.258	.116	.802	.037	.395	760	.465	.600	.218	.820	.409	.553
550	.218	.260	.123	.823	.036	.416	770	.465	.600	.218	.820	.409	.553

TABLE II — Relative Energy Distribution of Test Illuminants.

Wavelength mμ	Illuminant: Cool White Fluorescent	Natural Fluorescent	Special Cool White Deluxe Fluorescent	Light Blue Fluorescent Plus CIE Illuminant *A*	Modified Cool White Fluorescent	Northlight Fluorescent (British)	Tropical Daylight Fluorescent	6500K Fluorescent
404.7	60.6	80.7	111.4	33.5	66.6	29.8	49.6	69.7
435.8	138.3	223.0	293.9	71.7	152.3	84.2	154.2	188.4
546.1	77.8	79.6	108.7	46.0	85.5	50.0	69.1	86.7
578.0	23.9	27.3	24.8	14.6	26.3	14.6	21.2	25.9
380	0.6	0	26.8	11.5	0.6	5.8	12.1	17.0
390	4.4	1.1	26.8	16.0	4.8	16.3	20.4	24.8
400	12.3	11.0	30.2	22.5	13.5	26.9	31.2	34.5
410	21.1	21.7	32.2	31.2	23.2	44.2	42.3	44.5
420	31.6	31.9	36.9	41.9	34.7	59.6	55.0	57.7
430	39.1	40.7	40.9	53.0	43.0	78.8	65.8	73.8
440	45.1	48.9	46.3	62.5	49.6	92.3	76.5	88.9
450	51.0	56.4	53.0	71.1	56.2	103.8	86.7	99.7
460	55.4	61.9	57.7	78.6	61.0	113.5	92.3	109.5
470	58.3	65.5	59.7	85.7	64.2	120.2	96.9	115.2
480	59.4	67.4	60.4	90.3	65.4	122.1	96.9	115.8
490	59.3	67.0	64.5	94.0	65.2	121.1	94.2	116.3
500	58.3	64.5	76.7	96.8	64.2	117.1	91.7	114.0
510	57.2	61.6	98.8	98.6	63.0	113.5	85.6	111.5
520	56.9	59.2	108.0	100.1	62.6	110.6	82.3	107.5
530	60.0	60.5	105.5	100.6	65.8	107.7	79.4	105.4
540	68.6	68.2	100.6	100.8	75.5	103.8	82.7	102.5
550	83.7	81.9	96.8	100.4	92.0	101.9	90.8	100.5
560	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
570	113.6	115.5	104.1	99.5	105.0	100.0	106.2	100.1
580	123.3	131.0	106.1	99.1	106.6	100.0	108.7	103.7
590	121.5	139.0	107.3	99.3	106.4	101.9	103.3	107.2
600	111.9	135.0	112.1	99.9	104.6	103.8	92.7	107.0
610	94.7	124.2	124.1	100.4	102.4	103.8	76.2	104.3
620	78.0	108.9	135.5	101.0	104.2	96.2	62.9	99.2
630	48.6	93.5	140.2	102.1	85.8	84.6	49.2	89.9
640	37.4	75.5	139.7	103.3	53.5	73.1	38.7	79.1
650	28.1	58.1	127.0	105.0	41.2	59.6	30.2	68.2
660	21.5	44.0	114.2	106.9	30.9	48.1	22.7	57.2
670	15.8	35.2	94.1	109.5	23.6	36.5	17.7	46.6
680	12.3	26.4	70.6	111.8	17.4	28.8	13.5	37.9
690	10.1	20.4	62.4	114.3	13.5	21.2	10.8	30.3
700	8.4	15.4	33.5	116.7	11.1	13.5	8.5	20.0
710	7.7	11.4	19.4	119.3	9.3	9.6	7.1	14.0
720	7.3	8.5	2.0	121.7	8.5	5.8	5.7	10.0
730	7.1	7.0	0.0	124.0	8.1	3.8	4.6	6.0
740	7.1	6.0	0.0	126.4	7.9	1.9	4.0	4.0
750	6.8	4.8	0.0	129.0	7.9	1.9	3.1	2.0
760	6.4	4.4	0.0	131.0	7.1	0.0	2.3	1.0
770	5.5	3.7	0.0	133.0	6.1	0.0	0.0	0.5

changing the relative sensitivity of one to another, while keeping the relative spectral sensitivity of each receptor constant. The details of such transformations have been given by Wright[6] and Bouma,[7] among others, and it is not necessary to repeat them here. For the purpose of this work the color primaries suggested by Wright and Thompson[5] were used.

Since for this study the interest is concentrated in six small regions of the chromaticity diagram, it was expeditious to calculate the corresponding chromaticities shown in Fig. 1. In the figure, *A*, *B*, *C*, *D*, *F*, *G*, *H* and *I* are arbitrarily chosen chromaticities around *E*, which is the chromaticity of CIE Illuminant *B*. According to the computation for each of the other five chromaticity regions, *a* is the sample chromaticity which under an illuminant with the chromaticity *A* has the same appearance

TABLE III — Chromaticity of Natural Objects Under Test Illuminants.

Illuminant	White		Hand		Face		Tea		Butter		Beefsteak		Potato Chips	
	x	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*	*x*	*y*
CIE Illuminant *B*	0.348	0.352	0.417	0.371	0.421	0.365	0.428	0.399	0.431	0.430	0.525	0.342	0.468	0.420
Daylight Fluorescent (British)	0.356	0.365	0.414	0.393	0.415	0.384	0.426	0.422	0.428	0.445	0.503	0.363	0.460	0.443
Natural Fluorescent	0.366	0.339	0.433	0.371	0.433	0.360	0.433	0.398	0.443	0.420	0.530	0.346	0.480	0.421
Special Cool White Deluxe Fluorescent	0.355	0.347	0.432	0.377	0.432	0.366	0.439	0.404	0.431	0.427	0.543	0.345	0.476	0.424
Light Blue Fluorescent Plus CIE Illuminant *A*	0.348	0.364	0.416	0.383	0.420	0.376	0.426	0.410	0.427	0.440	0.524	0.349	0.464	0.430
CIE Illuminant *C*	0.310	0.316	0.375	0.348	0.379	0.341	0.391	0.380	0.402	0.415			0.437	0.411
Northlight Fluorescent (British)	0.306	0.328	0.367	0.364	0.369	0.354	0.383	0.395	0.389	0.427			0.426	0.426
Tropical Daylight Fluorescent	0.307	0.330	0.351	0.368	0.362	0.358	0.379	0.401	0.388	0.431			0.420	0.434
6500K Fluorescent	0.313	0.329	0.376	0.364	0.378	0.354	0.389	0.393	0.396	0.424			0.434	0.424

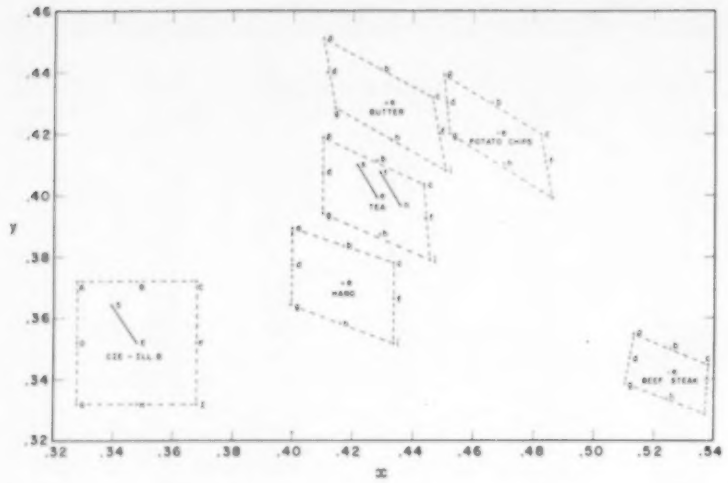


Figure 1. Chart for use in allowing for chromatic adaptation.

as e has under an illuminant with the chromaticity E. The sample chromaticity b corresponds to the illuminant chromaticity B and so on.

As an example of the application of Fig. 1, suppose that for an illuminant with the chromaticity shown at S, the test sample has the chromaticity shown at t. Since, according to the calculations, the sample having the chromaticity s would shift to e when the adaptation of the eye was complete, therefore the vector $\vec{se}$ determines how t must move, *i.e.*, to n, and n is the chromaticity which must be tested using the color tolerance ellipse.

Once the adaptation charts are prepared, it takes only a few seconds to determine the adjusted chromaticity. The apparent chromaticities (x_t, y_t) of all samples after adaptation are in Table IV.

(b) *Determination of the Subjective Color Deviation*

The optimum or preferred chromaticity for each test sample under a "Daylight" illuminant was considered to be the center of the tolerance ellipse (x_e, y_e) which is given in Table V. The value, $\Delta s/r_\theta$ was used as an indicator of the subjective deviation of the test chromaticity (x_t, y_t) from the preferred chromaticity. As shown in Fig. 2, Δs is the distance from the apparent chromaticity to the center of the appropriate tolerance ellipse, and r_θ is the radius of the ellipse in the same direction. The ratio may be determined by measurement

TABLE IV — Chromaticities of Natural Objects Corrected to Allow for Adaptation to the Illuminant Chromaticities.

Illuminant	White		Hand		Face		Tea		Butter		Beefsteak		Potato Chips	
	x_t	y_t	x_t	y_t	x_t	y_t	x_t	y_t	x_t	y_t	x_t	y_t	x_t	y_t
CIE Illuminant *B*	0.348	0.352	0.417	0.371	0.421	0.365	0.428	0.399	0.431	0.430	0.525	0.342	0.468	0.420
Daylight Fluorescent	0.348	0.352	0.407	0.387	0.408	0.378	0.419	0.417	0.422	0.442	0.498	0.361	0.454	0.441
Natural Fluorescent	0.348	0.352	0.418	0.385	0.418	0.375	0.428	0.413	0.425	0.436	0.518	0.356	0.464	0.437
Special Cool White Deluxe Fluorescent	0.348	0.352	0.426	0.383	0.426	0.372	0.433	0.409	0.424	0.434	0.538	0.349	0.469	0.431
Light Blue Fluorescent Plus CIE Illuminant *A*	0.348	0.352	0.416	0.375	0.420	0.368	0.426	0.403	0.428	0.430	0.524	0.344	0.465	0.424
CIE Illuminant *C*	0.310	0.316	0.375	0.348	0.379	0.341	0.391	0.380	0.402	0.415			0.437	0.411
Northlight Fluorescent (British)	0.310	0.316	0.371	0.355	0.373	0.345	0.389	0.384	0.395	0.416			0.432	0.416
Tropical Daylight Fluorescent (British)	0.310	0.316	0.364	0.356	0.365	0.348	0.384	0.388	0.393	0.418			0.425	0.426
6500K Fluorescent	0.310	0.316	0.373	0.353	0.375	0.343	0.387	0.383	0.394	0.416			0.433	0.416

TABLE V — Specification of the Ellipses Used in Calculating the Ratings of the Illuminants.

Object	For Illuminant Near CIE Illuminant *B*					For Illuminant Near CIE Illuminant C				
	Center		g_{11}	$2g_{12}$	g_{22}	Center		g_{11}	$2g_{12}$	g_{22}
	x_c	y_c				x	y			
Hand	0.414	0.374	1300	−2000	2000	0.402	0.368	1416	−2150	2979
Face	0.443	0.378	3400	−4800	20000	0.441	0.379	2615	−2594	15466
Tea	0.412	0.392	12230	−24800	17825	0.386	0.375	32930	−58940	32930
Butter	0.414	0.407	20500	−31100	27600	0.375	0.386	15630	−24340	15630
Beefsteak	0.544	0.350	378	364	1242					
Potato Chips	0.432	0.412	650	−1010	2100	0.422	0.415	939	−720	2695

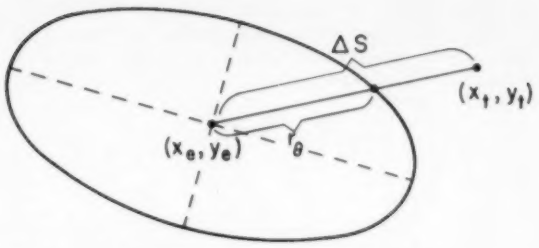


Figure 2 (above). Color tolerance ellipse showing geometrical determination of $\Delta s/r_\theta$.

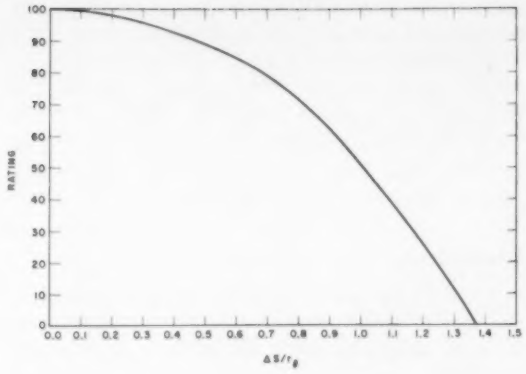


Figure 3 (right). Relationship between $\Delta s/r_\theta$ and rating.

or by using the formula proposed by MacAdam.[8]

$$(\Delta s/r_\theta)^2 = g_{11}\ (\Delta x)^2 + 2g_{12}\ \Delta x\ \Delta y + g_{22}\ (\Delta y)^2$$

where $\Delta x = x_t - x_e$

$\Delta y = y_t - y_e$.

Values of g_{ij} are listed in Table V, and the calculated values of $\Delta s/r_\theta$ are given in Table VI.

Since the unsuitability of a color is not necessarily proportional to $\Delta s/r_\theta$ it is desirable to return to a scale where the numbers have a meaning in the subjective sense. For each experiment described in Reference 1, judgments of Good, Fair to Good, Fair, Fair to Unsatisfactory, and Unsatisfactory were made on samples having a range of chromaticities. These judgments were converted to numerical judgments of 100, 75, 50, 25 and 0 respectively for averaging purposes and the average judgment was plotted at the measured chromaticity. An ellipse was drawn on the chromaticity diagram so it would pass through the chromaticities which were judged to give fair color rendition. Using this ellipse it is possible to determine $\Delta s/r_\theta$ for each chromaticity and since the average judgment is already known for each point, the judgment may be plotted versus $\Delta s/r_\theta$ and a curve may be drawn through the points. This procedure was repeated for five sets of observations and the five curves were averaged to give the curve shown in Fig. 3. This average curve may be used to find the judgment corresponding to the average values of $\Delta s/r_\theta$. The judgment of 50 should now mean that the illuminant will provide fair color rendition and so on.

Unfortunately, when this procedure is followed, one finds that all of the test illuminants including CIE Illuminant *B* are judged to be unsatisfactory. It seems that objects judged in isolation are more critically viewed than when they appear together in a complex field.

In order to eliminate this difficulty, CIE Illuminant *B* was arbitrarily assigned a rating of 85. To obtain this rating from the graph in Fig. 3 an illuminant would have to have an average $\Delta s/r_\theta$ of 0.60. CIE Illuminant *B* has 1.23 for the uncorrected average. Therefore, in order to find a color-rendering rating for the other illuminants, on the

TABLE VI — Subjective Displacement of Chromaticity, $\Delta s/r_\theta$, of Test Samples from the Preferred Chromaticity for "Daylight" Illuminants.

Object	Illuminant *B*	Cool White Fluorescent	Natural Fluorescent	Special Cool White Deluxe Fluorescent	Light Blue Fluorescent Plus Illuminant *A*	Modified Cool White Fluorescent	Deluxe Cool White Fluorescent
Hand	0.22	0.76	0.42	0.36	0.00	0.66	
Face	1.92	2.05	1.38	1.09	1.64	1.93	
Tea	1.09	2.71	1.76	1.30	0.85	2.25	
Butter	2.88	5.21	4.09	3.69	4.31	4.72	
Beefsteak	0.52	0.88	0.49	0.14	0.48	0.81	
Potato Chips	0.78	1.18	1.09	0.79	0.78	1.04	
AVE$\Delta s/r_\theta$	1.23	2.13	1.54	1.23	1.34	1.90	
Rating	85	46	76	85	82	60	
	Standard						
Figure of Merit	Blackbody 4500K at 100	59	64	75	91		83
Duplication Index	Blackbody 4500K at 100	58		69			76
Rendition Factor	BB 4400K at 100	79		95			96
Average Color Displacement	BB 4500K at 0	5.8	3.0	3.9	2.8		

scale which rates CIE Illuminant *B* at 85, all the uncorrected averages must be divided by 2.06. (This is equivalent to enlarging all the color tolerance ellipses by 2.06 times.) The ratings determined in this way are given in Table VI. Ratings of 100, 75, 50, 25, 0 correspond to judgments of Good, Fair to Good, Fair, Fair to Unsatisfactory and Unsatisfactory color rendition respectively.

Discussion

These ratings appear to rank the illuminants* in the correct order. However, since no absolute test for color rendition exists, the correct order is only a matter of opinion. For comparison, the values assigned to the color rendering quality of some of these illuminants by other methods are also given in Table VI. These are the Figure of Merit suggested by Harrison,[9] the Duplication Index assigned by the methods of Judd and Jerome,[10] the Rendition Factor obtained by Barr, Clark and Hessler,[11] and the Average Color Displacement given by Azuma and Mori.[12] Some of these assessments disagree with the qualitative impressions; *e.g.*, the Figure of Merit is nearly the same for cool white fluorescent and natural fluorescent lamps, whereas there is, in fact, a considerable difference in the color rendition by these lamps. The Duplication Index is lower for the special deluxe cool white than for the deluxe cool white lamps, although the special lamp is considered to be better and the Average Color Displacement is larger for the special deluxe cool white than for the natural daylight lamp, a finding which disagrees with the subjective impressions.

It is possible that these discrepancies (if they are discrepancies) are caused by using the displacements from the chromaticities under a standard illuminant (*i.e.*, from assuming that CIE Illuminant *B* or a blackbody radiator is ideal for all objects), instead of working with preferred chromaticities. Some errors could also be introduced by inadequate allowance for color adaptation. Since these other tests use colors in the total color gamut rather than those natural colors which most often are the cause of complaints of poor color rendition, this fact could cause discrepancies between these assessments and purely subjective impressions. On the other hand, the rating may be criticized because it considers only colors in the yellow-red region and may give a good rating to illuminants which render blues or greens poorly. It would indeed be an improvement to have included green peas and a purple fruit in the natural objects used to test the color rendition.

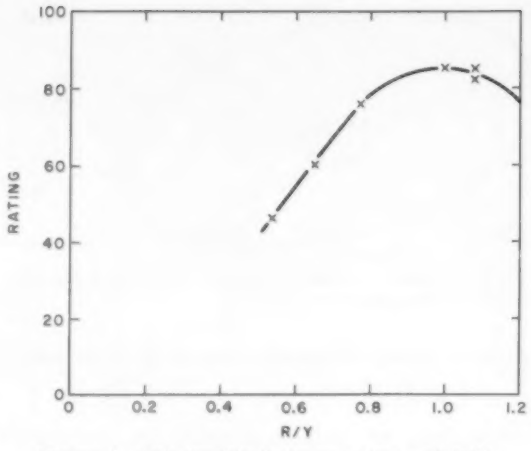


Figure 4. Relationship between rating and *R/Y*.

The improvement in rating obtained by reducing the yellow energy from the daylight fluorescent lamp suggested that further consideration of the color contrast factors described by Harrison[9] would be enlightening. The color contrast factor, *R/Y*, is plotted versus the rating for each illuminant in Fig. 4,

where $R/Y =$

$$\left(\int_{\lambda=610m\mu}^{660} E_\lambda \bar{y}_\lambda d_\lambda\right) \Big/ \left(\int_{\lambda=560m\mu}^{610} E_\lambda \bar{y}_\lambda d_\lambda\right)$$

The relationship which apparently exists suggests that one could just as well determine the quality of color rendition by determining *R/Y* and using it to find the rating from the graph in Fig. 4. Plots of the other color contrast factors versus the rating showed much poorer correlation.

"Northlight" Illuminants

The values of $\Delta s/r_\theta$ for "Northlight" illuminants are given in Table VII. It will be noted that no color tolerance ellipse was available for beefsteak for these illuminants, although a luminous reflectance tolerance for beefsteak is suggested in Appendix A. Since it is desirable to have the rating of the "Northlight" illuminants on a similar basis to the "Daylight" illuminants, some adjustment must be made for the absence of beefsteak as a test

*Note on Test Illuminants

The cool white fluorescent lamp is very similar to the daylight fluorescent lamp used in Britain. The natural fluorescent lamp is also a British type lamp, as is the light blue fluorescent source which uses a single phosphor. The latter was combined with enough CIE Illuminant *A* to give a mixture chromaticity near CIE Illuminant *B* so it could be tested against the color tolerance ellipses. (In this mixture the energy from CIE Illuminant *A* at 560 mμ was 56.0. From this fact the reader may calculate the spectral distribution of the components.) This illuminant has a good color rendering quality, being only slightly poorer than CIE Illuminant *B* or the special cool white deluxe fluorescent lamp.

The modified cool white fluorescent lamp was provided by reducing the energy from the cool white fluorescent lamp in the wavelength region from 560 mμ to 610 mμ. This change results in a considerable improvement in the rating and suggests that the intense yellow phosphor is the cause for the poor color rendition by this lamp.

Finally, it should be noted that the spectral energy distribution of the lamps considered was that prevalent in 1954-1955 and that lamps with the same name may now be somewhat improved in color rendering properties.

TABLE VII — Subjective Displacement of Chromaticity, $\Delta s/r_\theta$, of Test Samples for the Preferred Chromaticity for "Northlight" Illuminants.

Object	CIE Illuminant C	Northlight Fluorescent	Tropical Daylight Fluorescent	6500K Fluorescent
Hand	1.05	1.00	1.22	0.90
Face	5.13	4.90	4.72	4.98
Tea	0.48	1.18	2.66	1.28
Butter	2.34	2.39	2.65	2.43
Potato Chips	0.54	0.30	0.56	0.33
Ave $\Delta s/r_\theta$	1.91	1.95	2.36	1.98
$(\Delta s/r_\theta)/2.31$	0.82	0.85	1.02	0.86
Rating	70	67	47	66

sample. The average $\Delta s/r_\theta$ for CIE Illuminant *B* when beefsteak is excluded is 1.38, which divided by 2.31 equals 0.60 and gives CIE Illuminant *B* a rating of 85. Therefore, the average value of $\Delta s/r_\theta$ for each "Northlight" illuminant was divided by 2.31 before using the curve in Fig. 3 to determine the rating.

Since CIE Illuminant *C* receives a rating of 76, the conclusion may be drawn that "cooler" illuminants are not as suitable for these particular natural objects. This suggests that "warmer" illuminants than CIE Illuminant *B* may be even better, and the general preference for tungsten lamps in the home supports this suggestion. Once again the rating appears to place the illuminants in the correct order. However, more illuminants need to be considered before the rating could be used unequivocally.

Conclusions

The procedures in this paper are not proposed as being the ultimate for determining the quality of illuminants. They do, however, demonstrate a method of determining a quantitative color rendering rating which is based on the color tolerance ellipses for natural objects. Apparently it is not possible to provide a single illuminant which renders all objects in the optimum way. In fact, a separate special illuminant may be desirable for each one of the natural objects. Although not usually practical, such a procedure is, in fact, followed to some extent in the groceterias where different lamps are used for meat counters and vegetable counters, while still different lamps may be used for general illumination. Although the rating does not determine what color temperature lamp to use, it does suggest that warmer illuminants are preferred for these particular objects. The rating may usefully be used to test illuminants of the "cool white" type which are being considered for illumination in the home or in restaurants, and may be determined approximately by using the R/Y color contrast factor.

Acknowledgements

It is again a pleasure to express my appreciation to Professor W. D. Wright of Imperial College, London, for his kind suggestions and criticisms, and to acknowledge with thanks an internal award from the National Research Council of Canada which made the research possible.

References

1. Sanders, C. L.: "Color Preferences for Natural Objects," ILLUMINATING ENGINEERING, Vol. XLIV, No. 7, p. 452 (July 1959).
2. Judd, D. B.: "Hue, Saturation and Lightness of Surface Colors with Chromatic Illumination," *Journal of the Optical Society of America*, Vol. 30 (1940).
3. Evans, R. M.: "Visual Processes and Color Photography," *Journal of the Optical Society of America*, Vol. 33, p. 579 (1943).
4. Winch, G. T. and Young, Brenda M.: "Color Rendering of Fluorescent Lamps and Binocular Viewing Investigations, ILLUMINATING ENGINEERING, Vol. L, No. 7, p. 353 (July 1955).
5. Wright, W. D. and Thomson, L. C.: "Convergence of the Tritanopic Confusion Loci and the Derivation of the Fundamental Response Functions," *Journal of the Optical Society of America*, Vol. 43, p. 890 (1953).
6. Wright, W. D.: *The Measurement of Colour*, Hilger, London, 1944.
7. Bouma, P. J.: *Physical Aspects of Colour*, Philips, Eindhoven, 1947
8. MacAdam, D. L.: "Specification of Small Chromaticity Differences," *Journal of the Optical Society of America*, Vol. 33, p. 18 (1943).
9. Harrison, W.: "Assessment of Colour Rendering Properties of Fluorescent Lamps," *Light and Lighting*, Vol. 44, p. 148 (1951).
10. Judd, D. B. and Jerome, C. W.: "Specification of Color Rendering Properties of Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. XLVIII, No. 5, p. 259 (May 1953).
11. Barr, A. C., Clark, C. M. and Hessler, J.: "Evaluation of Color Rendition by Fluorescent Lamps—An Exploratory Study," ILLUMINATING ENGINEERING, Vol. XLVII, No. 12, p. 649 (December 1952).
12. Azuma, T. and Mori, L.: "An Appraisement of the Color Rendering Properties of Fluorescent Lamps," *Journal of the Illuminating Engineering Institute of Japan*, Vol. 38, p. 187 (1954).
13. Bouma, P. J.: "Two Methods of Characterizing the Colour Rendering Properties of a Light Source," *Proceedings of the C.I.E.*, Vol. 2, p. 57 (1939).
14. "Bands Suitable for Testing Color Rendition," *Proceedings of the C.I.E.*, p. 18 (1948).
15. MacAdam, D. L. and Brown, W. R. J.: "Visual Sensitivities to Combined Chromaticity and Illumination Differences," *Journal of the Optical Society of America*, Vol. 39, p. 808 (1949).

APPENDIX A—AN EXAMPLE OF A SPECIAL TEST FOR COLOR RENDITION OF A PARTICULAR OBJECT: BEEFSTEAK

The problem of assigning a color tolerance for beefsteak was more difficult than it was for the other natural objects, because of the relatively rapid change in color of unrefrigerated beefsteak and the facets of specularly reflected light. There was, therefore, some doubt about the validity of the color tolerance ellipse. Furthermore, the lightness of beefsteak seemed to be more important than the chromaticity. An experimental attempt was made to determine a tolerance for lightness, but the above-mentioned specular reflection made the results useless.

Therefore, consideration was given to the problem of setting a tolerance based on semi-theoretical grounds. Since the reflectance decreases as the meat becomes staler, the luminous reflectance may be a suitable criterion for color rendition of beefsteak. The color tolerance ellipses have approximately the same shape as the MacAdam and Brown[15] ellipses, therefore it seems reasonable to assume that the tolerance ellipsoids also have similar shapes to the color matching ellipsoids. Assuming that differences exist only in the luminous reflectance L, then $(\Delta s/r_\theta)^2 = g_{33}\,\Delta l^2$,

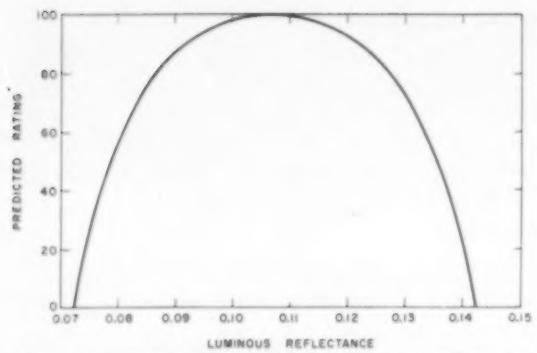


Figure A-1. Suggested relationship between rating and luminous reflectance of beefsteak.

where $l = 0.2 \log Y$. Furthermore, by making the additional assumptions that the luminous reflectance of beefsteak under CIE Illuminant *A* (which equals 0.106) is ideal and rated at 100; and that $Y = 0.089$ under CIE Illuminant *B* would be rated 85, then g_{33} works out to be 0.66×104. The resulting equation, $(\Delta s/r_g)^2 = 0.66 \times 10^4 \, \Delta l^2$, when used in conjunction with the curve relating Judgment and $\Delta s/r_g$ shown in Fig. 3, determines the relationship which is shown in Fig. A-1.

It should be emphasized that this relationship is based on the use of the spectral reflectance values for beefsteak which are given in Table I, and that the use of other spectral reflectance values would result in the establishment of a different curve. It will be noted that too high a luminous reflectance leads eventually to poorer color rendition.

TABLE A-I—Predicted Color Rendering Rating of Various Illuminants When Used for Illuminating Beefsteak.

Illuminant	Luminous Reflectance Y	Rating Predicted by Reflectance	Judgment Based on the Color Tolerance Ellipse
CIE Illuminant *A*	0.106	100	
CIE Illuminant *B*	0.089	85	88
CIE Illuminant *C*	0.084	72	
Cool White Fluorescent	0.076	34	64
Northlight Fluorescent	0.078	49	
Natural Fluorescent	0.086	79	89
Special Cool White Deluxe Fluorescent	0.090	87	99

The luminous reflectance of beefsteak for several test illuminants is given in Table A-I. The judgments determined by the relationship in Fig. A-1 may be compared with the judgment of color rendition based on chromaticity. It will be seen that the reflectance test gives the illuminants lower ratings than does the test using the color tolerance ellipses. Also, there is a reversal in one case, and since all the illuminants were not available to check these results directly, it is not known which is correct. However, since the test using only reflectance avoids the adaptation problem, it may be used for lamps with a wide range of color temperatures. Furthermore, since there are fewer calculations involved in the reflectance test it was felt that it should be suggested as a possibly useful tool.

High Levels in Hardware Store

Initial level of illumination was 280 footcandles in this Alliance, Ohio, hardware store, where much of the merchandise is out in open display. Three continuous rows of suspended luminaires have wedge-shaped louvers and use extra-high-output lamps. Photo and data courtesy General Electric Co., Cleveland, Ohio.

How to Improve Ballast Testing

By W. W. BROOKS

WHEN IT comes to ballast testing, "there is nothing like a lamp." The reason for this is that the nonlinear relationship between lamp voltage and current cannot be duplicated with any known circuit. Therefore, data obtained by testing without a lamp do not indicate true ballast adjustment. Since this is the case, all laboratories testing ballasts, even though they have learned to use lamps in spite of their variable electrical characteristics, have continued to search either for some means to test ballasts without lamps, or for some way to make lamps constant electrically.

A brief review of the procedure for testing rapid start fluorescent lamp ballasts[1] will help to focus the problem. The given fluorescent lamp ballast to be tested is connected to a circuit for switching stable, seasoned, fluorescent lamps to the ballast after they have been operated on reference ballast circuits long enough to stabilize them as well as possible. First, currents of photocells responsive to the light output of each of the lamps are read after the lamps have been switched to the test ballast without being extinguished. Second, the lamps are returned to the reference ballast and are read again. From these readings percentages proportional to relative light output are obtained by dividing the photocell current corresponding to test ballast light output by the photocell current corresponding to reference ballast light output and multiplying by 100.

When comparative tests are used to determine the relative merit of ballast design modifications, it is customary to compare the electrical characteristics of the reference lamps each time they are switched to reference ballasts. If these electrical characteristics are different, it is normal to suspect the relative accuracy of the per cent light output values calculated for each ballast.

This paper presents the preliminary results obtained by using a new method for stabilizing fluorescent lamps. More specifically, a few of the tests involved extra high output lamps (PG17 1500 ma), but most of them were on high output lamps. Although insufficient data are available to answer all questions concerning absolute accuracy and repeatability of the method, it appears worthy of further trial and study.

AUTHOR, Consulting Engineer, Ballast Dept., General Electric Co., Danville, Ill.

Why Improve Testing Procedure?

Through the years ballast manufacturers have contributed to the steady reduction in the cost of fluorescent lighting by reducing the size of ballasts and by designing and manufacturing ballasts to meet steadily increased ranges between limits on temperature, noise and per cent light output characteristics. The continuation of the process has resulted in an increasing need for measuring light output more accurately in order to assure the detection of valuable cost reduction innovations. Upon the introduction of the 800 and 1500 ma fluorescent lamps it became evident that improvement in testing procedure could not be postponed. When testing these higher current lamps, it became very difficult to decide precisely when the lamps were sufficiently constant to read. Thus, the waiting time became much greater, without increasing the accuracy of the results. In fact, accuracy decreased. One of the means of correcting this decrease in normal testing accuracy and of increasing confidence in ballast test results was the use of the method of repeating the tests of a given ballast a sufficient number of times to obtain a statistical indication of per cent light output. However, this increased the testing time undesirably but did not insure that the lamps were conditioned properly.

Another procedure to minimize this problem, adopted by design engineers, was to conduct contemporary comparative tests. This too increased testing time and unless the comparative readings were taken faster than lamps varied, there was no improvement in relative accuracy. Furthermore, there was no improvement in absolute accuracy.

How to Improve Testing Procedures

The type of variations in the reference ballast-lamp operating level which forced the decision to study the problem is shown in Table I. (These data are repetitive tests on one pair of lamps taken over a period of two hours.)

With the advice and guidance of lamp engineers the recognized causes for large variations in calculated per cent light output were studied. This re-

TABLE I—Series of Per Cent Light Indications Taken on Two Extra High Output Rapid Start (PG17 1500 ma) Fluorescent Lamps Operating on Reference Ballasts. This shows the variability of results which prompted the investigation of testing methods.

Test No	Per Cent Light Output	
	Lamp No. 1	Lamp No. 2
1	100	100
2	101.2	100.2
3	103	101.2
4	102.6	101.5
5	104.4	102
6	105	103.2
7	106.8	103

sulted in the selection of the following significant ones for further investigation.

(1) Temperature-dependent lamp characteristics changes caused by variations in:
  (a) Ambient air movement
  (b) Ambient air temperature
  (c) Power supplied to the lamp.
(2) Variations in reference ballast adjustment.
(3) Variations in test ballast resistance due to variations in the length of time the ballast was "on" before readings were taken.
(4) Variations in photocell-circuit response.
(5) Variations in the voltage of the source.

In order to rank the above causes for variation according to importance, and to learn whether or not any salient ones had been omitted, lamps were operated under controlled conditions.

Because temperature variations and drafts were thought to have a significant influence on lamp characteristics, the investigation was started by operating a given lamp in ambient conditions where temperature varied from 25-27.5C and the air velocity was fairly constant at about 20 feet per minute. The test system consisted of a power source, a reference ballast, a light comparison measurement device, a fluorescent lamp and electrical instruments. Using the same instruments and reference ballast adjustment, to minimize the influence of their variations on lamp characteristics, the photocell current (light output indication) was observed. After various tests of the type summarized in Table II, it was apparent that the indicated light output from the lamp was continuously varying and that very likely either the lamp temperature was not sufficiently closely controlled or there was some unrecognized variable (or variables). After further consultation with lamp engineers, it was decided that the mercury vapor pressure (the one lamp parameter known to be principally responsive to temperature and causing lamp voltage to change) in the lamp must have been changing excessively and that a better means of control was required. Many attempts were made to gain control before one method yielded results of the type shown in Table III. It was decided that this approach could produce the desired stability. Accordingly, work proceeded along that line until the arrangement shown in Fig. 1 was developed. In order to simplify discussion of this method it will be called the method of "External Temperature Control" and will be abbreviated to the "ETC" method. Fig. 2 shows a 50-minute comparison of the stability of the light output from two lamps one of which was controlled by the ETC method and the other, uncontrolled. Preliminary investigation of other causes for variation indicated that careful laboratory practice would prevent them from producing serious variations in results.

Next an attempt was made to ascertain if the

TABLE II—Variation in Extra High Output (PG 17 1500 ma) Lamp Characteristics when Lamp was Unshielded in Temperature-Controlled and Draft-Limited Ambient.

Elapsed Time in Hours	Watts	Amps	Volts	Photocell Current (Light Output)	Ambient Air Temperature Degrees C	Lamp Bulb Temperature Degrees C
0	197.0	1.498	155	336	26	43.8
0.42	196.2	1.485	151	334	26	44.1
2.69	194.0	1.50	150.2	327	27	46.4
3.0	192.0	1.485	154.0	330	26	44.8
3.25	192.0	1.485	154.0	330	26	44.8
3.42	194.0	1.495	152.0	329	27.5	45.2

TABLE III—Variations in High Output Lamp Characteristics when Temperature of Liquid Mercury in Lamp was Closely Controlled.

Elapsed Time in Hours	Watts	Amp	Volts	Photocell Current (Light Output)	Ambient Air Temperature Degrees C	Lamp Bulb Temperature Degrees C
0.0	105.6	0.810	150.0	501	26.9	49
0.27	105.7	0.810	150.2	500	27.1	49
0.43	105.7	0.811	150.1	501	27.2	49
1.15	105.8	0.811	150.3	501	27.2	49
1.32	105.7	0.810	150.0	501	27.2	49
2.00	105.6	0.810	150.0	500	27.4	49
2.53	105.6	0.810	150.0	501	27.7	49
19.25	105.8	0.811	150.2	499	25.6	49

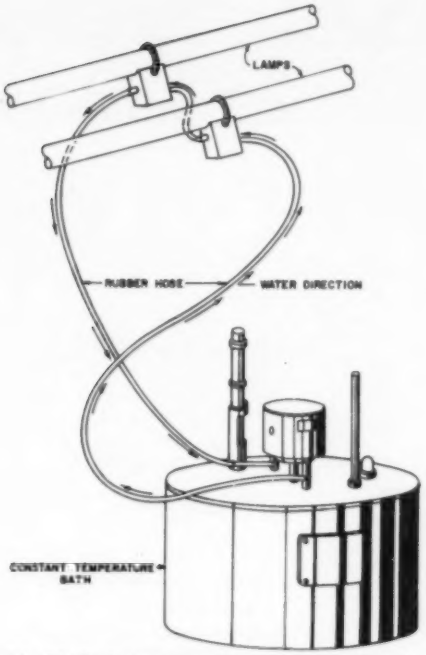


Figure 1. Method of external temperature control of the bulb wall of fluorescent lamps.

repeatability of measurement was satisfactory. Representative results obtained by making a series of measurements are shown in Table IV. These results indicate a variation of plus and minus 0.05 per cent in the No. 1 lamp light output and minus 0.03 to plus 0.18 per cent in the No. 2 lamp light output.

A comparison of the results of the ETC method with those obtained in a different laboratory ten months earlier is shown in Table V. The method used[2] in Laboratory B promoted lamp stabilization in a controlled ambient. Using this method, 24 repeat measurements were made, with five different lamps, to provide data which were then treated statistically.

After studying results of the type shown in Fig. 2, plus Tables IV and V, it appeared that most of the causes for lamp instability were included in the original list since when all of them were controlled as well as possible, lamp light output was fairly constant.

Other methods which were considered for control of lamp characteristics were not found to be as practical as the method of Fig. 1. This was because none of them enabled the tester to adjust lamp voltage to within reference lamp limits[2] in as precise a way as the ETC method.

Results of the investigation indicated that the method shown in Fig. 1 could be relied upon to control the electrical characteristics of a fluorescent lamp within close limits. Since there is a small

TABLE IV—Results of Successive Measurements (Using ETC Method) of Per Cent Light Output of Two-Lamp, 96-Inch, High Output Lamp Ballast.

Elapsed Time in Hours	Per Cent Light Output No. 1 Lamp	No. 2 Lamp	Temperature of Water in Constant Temperature Bath in Degrees C
0	95.75	95.2	49
0.25	95.80	95.3	49
2.18	95.70	95.0	49

TABLE V—Comparison of Per Cent Light Output of Two-Lamp 96-Inch High Output Lamp Ballast as Indicated by Two Different Measurement Methods.

Method	Per Cent Light Output No. 1 Lamp	No. 2 Lamp
ETC	95.75	95.2
Laboratory B	95.64	95.18

normal variation in the characteristics of fluorescent lamps, it is desirable to check those lamps selected to make sure they will operate within ± one per cent at the same reasonable water temperature.

One other known characteristic of the method is that the bulb wall temperature selected to cause the lamp to operate within reference lamp limits on voltage, current and power is truly correct only for the power level supplied to the lamp when operating on the reference ballast. Another somewhat lower bulb wall temperature would be correct for the lower power operation. Therefore, the ETC method should cause the per cent light output of a given test ballast to appear lower than the true value, if the test ballast operated lamps at a power level below reference ballast level. A long range test is underway to evaluate this characteristic of the ETC method and when sufficient data are available its nature will be reported.

The process of lamp selection which has been used is the arbitrary selection of a lamp which has operated about 100 hours on a reference ballast or nearly normal production ballast. Next, the lamp

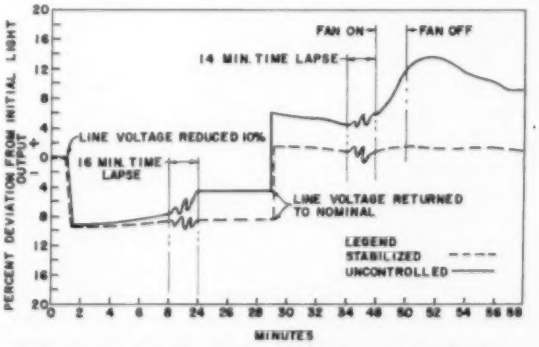


Figure 2. Comparison of stability of an "ETC" lamp and an uncontrolled lamp.

is placed in operation on a reference ballast, and a heat exchanger is attached to the center of the lamp, as indicated in Fig. 1. The lamp is thermally insulated with asbestos or the equivalent to raise the temperature of all of the parts except the area being cooled with the heat exchanger. Temperature of the water in the constant-temperature bath is adjusted to approximately 20C and lamp voltage is read from time to time. Initially, a period of 8-16 hours will be required for the liquid mercury in the lamp to collect on the lamp bulb wall where the heat exchanger is attached. However, while the lamp is insulated with asbestos, when the mercury has collected and is all at 20C, there will be a spectacular change in lamp voltage of the character shown in Fig. 3. When this change has taken place the lamp is ready to use. Now, by increasing the temperature of the water in the constant-temperature bath to a higher value (about 49C for high output, rapid start fluorescent lamps) the lamp characteristic can be adjusted. The relationships between lamp characteristics and bath temperature are shown in Fig. 4 for one F96T12/HO lamp. From this drawing it can be seen that temperature may be adjusted to cause lamp voltage to be nominal. When this has been done, and lamp insulation has been reduced such that the temperature of the controlled area is 5-10C less than any other part of the lamp, if watts and amperes are within reference lamp limits, the lamp is ready to be used for testing ballasts. For testing multi-lamp ballasts, it is a convenience to select a set of lamps which operate at very nearly the same voltage, power and current at the same water temperature.

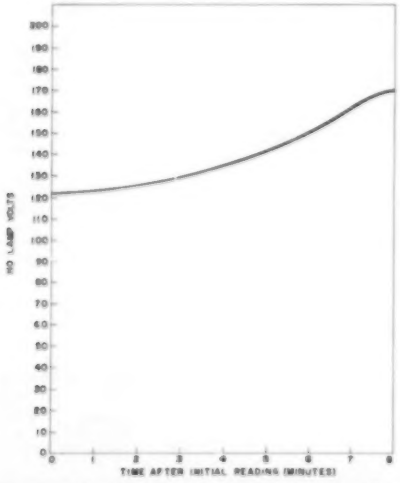


Figure 3. Rapid rise in F96/T12/HO lamp voltage due to condensation of mercury in this locally cooled area of the lamp bulb wall after several hours of continuous operation on a reference ballast.

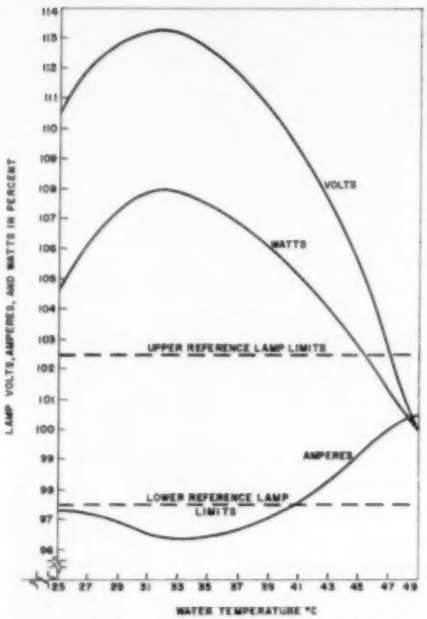


Figure 4. Relation between lamp characteristics and water temperature for an F96T12/HO lamp operated by a reference ballast.

Conclusions

Inconsistent measurements of per cent light output of fluorescent lamp ballasts instigated a study of the testing procedure. The findings indicated that the chief cause of variability was variation in lamp characteristics due to changes in ambient temperature and draft. An investigation disclosed that the influence of these variables was minimized by controlling the temperature of a localized area of the lamp bulb.

Using controlled lamps, preliminary evaluation of ballast test results showed that the variation in per cent light output was reduced from 6.8 per cent to 0.23 per cent. It was recognized that this method does not permit lamp temperature to fall when the lamp is operated on a low per cent light output ballast or rise when operated on a high per cent light output ballast. Accordingly, steps were taken to evaluate this effect and the results will be reported later.

In the meantime, this method has so much merit that it justifies urging fluorescent lamp manufacturers, testing laboratories and ballast manufacturers to investigate it and to cooperate in the preparation and adoption of a testing procedure making use of lamps stabilized in this manner.

References

1. *American Standard Methods of Measurement of Fluorescent Lamp Ballasts*, C82.2-1958, Section 13.2.
2. *American Standard Specification for Fluorescent Lamp Ballasts*, C82.1-1958, Section 2.2.

Lighting for Low-Ceiling Classrooms

Prepared by the Subcommittee on Lower Ceiling Classrooms of the Daylighting Committee of the Illuminating Engineering Society

FOREWORD

Due to the post-war trend toward lower ceilings in classrooms, it has been necessary for both the School and Daylighting Committees to think in terms of appropriate lighting for such classrooms. This report is a result of these efforts.

SUBCOMMITTEE ON LOWER CEILING CLASSROOMS

H. F. Kingsbury, *Chairman*

C. J. Allen — R. V. Hall
J. W. Griffith — C. A. Winkelhake

DAYLIGHTING COMMITTEE

H. B. Vincent, *Chairman*
J. W. Griffith, *Vice-Chairman*

W. J. Arner — E. M. Linforth
L. E. Barbrow — W. F. Little
R. A. Boyd — T. H. MacDonald
R. L. Biesele, Jr. — H. E. Machamer
A. A. Brainerd — Murray McDavitt
H. S. Bull — R. W. McKinley
E. W. Conover — E. C. Miles
D. Early — F. W. Mowrey
W. B. Ewing — R. H. Reed
C. D. Gibson — F. K. Sampson
B. F. Greene — P. W. Seagers
J. S. Herbert — D. E. Spencer
G. N. Hingston — K. C. Welch
R. C. Kendall — O. F. Wenzler
H. F. Kingsbury — C. J. Youngblood

1. Introduction

(a) With the greatly expanded enrollment of children in schools, as well as the requirements for replacement of obsolete facilities, architects and school boards have looked into many means of lowering school building costs, so that more classrooms can be built with the available money. One of the ways that some architects decided costs might be cut was by reducing the ceiling height of classrooms and thereby saving something in perimeter walls. Whether worthwhile savings can in fact be achieved is extremely difficult to determine and is a continuing subject of discussion.

(b) In the past five years many types of low-ceiling classrooms have been built, with a great variety of ceiling heights and lighting solutions, and with varying results as far as lighting quality is concerned. Many states have changed school codes recently, and in effect if not by statement, are placing the main dependence on electric light as the primary source, rather than daylight. Nonetheless, one of the criteria still used in judging the adequacy of classroom lighting is how good the daylighting is.

(c) It is the purpose of this report to define properly the meaning of "low-ceiling" classrooms and offer recommendations aimed at producing recommended quality and quantity of daylighting in such structures.

(d) Nothing in these recommendations is to conflict with the "Recommended Practice of Daylighting,"[1] and further information regarding the general principles of daylighting design may be obtained from that publication.

2. Definition of Low-Ceiling Classroom

(a) For the purposes of better understanding of the daylighting requirements and recomendations, a low-ceiling classroom is defined as one in which the ceiling height *at the main fenestration* is 10½ feet or less, or where the room depth exceeds the ceiling height at the main fenestration by more than 2½ times.

(b) By defining room height or depth as a function of height at the main fenestration, two purposes are accomplished: (1) the room height at the main fenestration determines, from the daylighting point of view, whether the room may be classified as "low-ceiling," and (2) it takes into account a sloping ceiling, whether it slopes up or down from the main fenestration being relatively unimportant.

3. Methods of Daylighting Low-Ceiling Classrooms

3.1—*General*—Since the design of low-ceiling classrooms represents a departure, in some uses quite radical, from the classic proportions of depth 2 to 2½ times the height, care and skill must be used in such design to obtain optimum lighting results.

3.2—*Sidewall Fenestration*—(a) The sidewall fenestration should extend from a "normal" sill height to a head which is as close to the ceiling as possible.

(1) Normal sill height may be any height from approximately two to four feet, depending on the architect's desires, state and local codes, and the type and amount of mechanical equipment to be placed beneath the sill.

(2) A design feature which has been seen in a number of installations is to drop the window head one to three feet below ceiling line. This is highly undesirable. With most fenestration materials, and for light from above the horizon, it is the upper portion of the window that is most effective in lighting the interior portions of a room. By lowering the head, quite obviously it is this portion of the window that is being eliminated. The reduction in total area of the window also adversely affects the quanity and quality of the daylight within the room. A third factor, which may be somewhat less important than the others mentioned above, is that the blank area between the head and ceiling line may cause an annoying brightness difference between the fenestration and this blank area, even when decorated with high reflectance material.

Approved by the Council of the Illuminating Engineering Society, July 1958. A Transaction of the I.E.S.

Figure 1. Classroom using diffusing glass clerestory in combination with side-wall fenestration.

(b) All opaque dividers within the fenestration area should be as narrow as possible. While it is generally accepted practice for muntins, mullions, pilasters, columns, etc., that occur in fenestration areas to be narrow, it is of even greater importance in connection with low-ceiling classrooms. Since the gross area of fenestration is smaller than in higher ceiling rooms, it is of greater importance to keep the net light transmitting areas as high as possible, and to reduce opaque areas as much as possible.

(c) Brightness control devices should be supplied for all fenestration areas.

(1) Brightness control items include: roller shades, louvers, translucent drapes, overhangs, glass blocks, or low transmittance glazing (plastic or glass).

(2) No matter what type of brightness control is used, it should be carefully engineered to integrate with the remainder of the room design, so as to obtain the maximum amount of daylight commensurate with adequate brightness control. To illustrate, a skimpy or over-large overhang will adversely affect either quantity or distribution; nearly opaque drapes or roller shades, while adequately controlling brightness, may decrease the amount of daylight unecessarily, and it is therefore necessary to consider quite carefully the type and amount of brightness control required.

3.3—*Overhead Fenestration* — **(a)** Overhead fenestration areas of controlled brightness should be provided in all low ceiling classrooms, especially those exceeding either or both criteria in the definition.

(b) Room depth remaining the

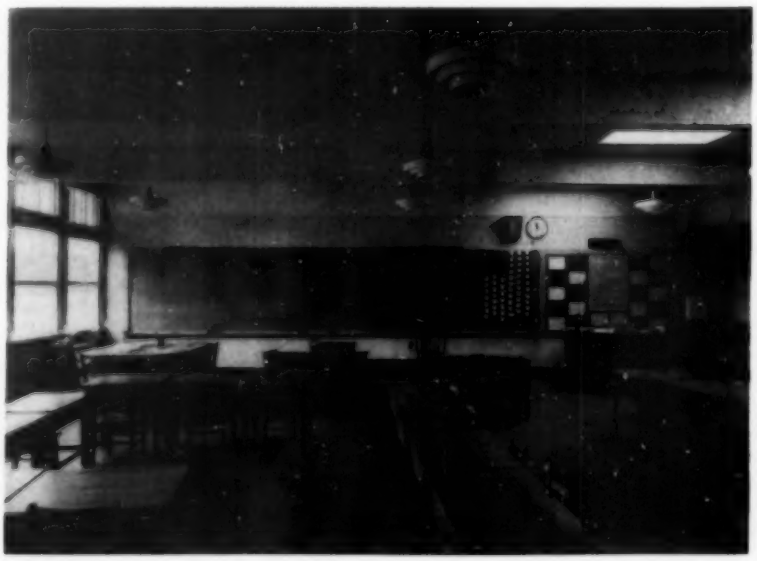


Figure 2. Classroom using skylights in combination wtih side-wall fenestration. Skylights are diffusing plastic domes.

Figure 3. Classroom using skylights in combination with side-wall fenestration. Skylights are clear plastic domes over wooden louvers.

Figure 4. Solution of daylighting problem in low-ceiling classroom-library using skylights in combination with side-wall fenestration.

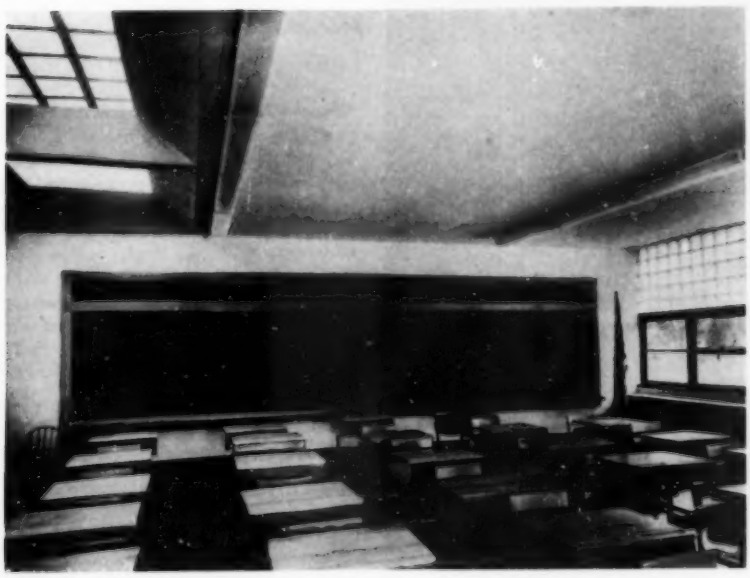


Figure 5. Clerestory in combination with side-wall fenestration solves daylighting problem in this low-ceiling classroom.

same, the lowering of ceiling heights may lower the amount of light at the inside of the room, by a greater degree than it is near the window wall, resulting in poorer distribution and higher task brightness to fenestration brightness ratios near the inside of the room.

(c) Such supplementary fenestration areas may take the form of bilateral fenestration, clerestories, or skylights.

(1) Bilateral fenestration, meaning two approximately equal light transmitting areas in different walls at nearly the same sill heights, should not, in normal rectangular rooms be mounted in adjoining walls, since the light distribution and brightness ratios of task to fenestration are not normally significantly improved by this construction.

(2) Clerestories may be either unilateral (facing the same way as the main fenestration) or bilateral (facing in a different direction). However, they should not be mounted in a wall adjoining the main fenestration, since the utility of the fenestration is decreased by such positioning.

(3) Such clerestory areas should not be less than approximately ten per cent of the floor area to effectively supplement the main fenestration.

(4) Skylights may be of plastic, glass or glass block. Since horizontally mounted light admitting areas frequently are more effective than vertical ones, the area should not be less than six per cent of the floor area. Generally speaking, skylights should be mounted two-thirds of the room depth from the main fenestration, although the placement is affected by the amount and type of main fenestration and should, therefore, be adapted to the specific design.

3.4—*Classrooms of Unusual Design*—(a) While the great majority of classrooms being built in America are either rectangular or square in shape, a considerable number employing different geometric shapes, such as pentagons, hexagons, or octagons, have been built. Frequently, the aim of these designs has been to increase the fenestration area in relation to the floor area, to obtain better daylighting. Some such designs have been quite successful from this point of view, but since final evaluation of their utility is dependent on other factors, such as educational usage, further comment is beyond the scope of this Committee.

(b) Completely top-lighted classrooms have also been built, with apparently good lighting quality, but evaluation is again dependent on other factors.

4. Coordination of Daylighting and Electric Lighting

(a) Since it is obvious that adequate daylight cannot be provided at all times during the school day in all areas, electric lighting is required in all classrooms, and obviously must be provided where nighttime usage is anticipated. However, the coordination of the two sources of light can be much improved, especially in the design stage and also in the operation stage. Such improved coordination will result in better quality lighting in classrooms and greater operating economies.

(b) The usage and economics of various automatic electric light controllers available should be carefully evaluated for particular geographic areas and specific designs. Such evaluation is beyond the scope of this Committee.

1. "Recommended Practice of Daylighting," ILLUMINATING ENGINEERING, Vol. XLV, No. 2, pp. 107-139 (February 1950). Revision to be published.

Current Office Practice

Two-lamp louvered troffer units mounted on four-foot centers provide 100 footcandles of comfortable lighting in general office area at Standard Oil of Indiana, Whiting, Ind. Units are equipped with F40T12 cool white lamps. Light walls and floors, acoustical ceiling and air conditioning add to pleasantness of the surroundings. Photo and data courtesy of General Electric Co., Cleveland, Ohio.

I.E.S. Guide for

Photometric Measurements Of Mercury Lamps

Prepared by the Subcommittee on Guide for Photometric Measurements of Mercury Vapor Lamps of the Committee on Testing Procedures for Illumination Characteristics of the Illuminating Engineering Society

FOREWORD

This guide has been prepared to promote greater uniformity of photometric test results among various laboratories. A "Guide for Electrical Measurements of Mercury Vapor Lamps" was issued in 1956.

SUBCOMMITTEE ON GUIDE FOR PHOTOMETRIC MEASUREMENTS OF MERCURY VAPOR LAMPS

J. S. Franklin, *Chairman*

G. E. Davidson	J. H. Park
M. H. Gabriel	Priscilla Presbrey
Mac Harris	E. H. Salter
T. H. Leister	A. W. Weeks
F. M. Neal	J. W. Young

P. L. Young

COMMITTEE ON TESTING PROCEDURES FOR ILLUMINATION CHARACTERISTICS

A. W. Weeks, *Chairman*

J. E. Bock	C. E. Leberknight
R. D. Bradley	T. H. Leister
G. E. Davidson	J. H. McCulloch
Don Davis	Phelps Meaker
Stephen Downey	G. A. Meyers
D. M. Finch	F. M. Neal
J. S. Franklin	Priscilla Presbrey
W. G. Hill	E. H. Salter
G. A. Horton	R. L. Smith
W. H. Houston	R. P. Teele
B. F. Jones	Maxwell Trostle
A. E. Krawcek	W. W. Weld
Paul Lamson	E. H. Witte

P. L. Young

1. Objective

It is the object of this report to provide a guide to promote uniform test results in measuring the luminous flux and intensity of mercury lamps under controlled laboratory conditions. This guide contains information pertaining to the measurement of light only. Two methods are:

(1) *The Integrating Sphere Method* by which total luminous flux may be measured directly.

(2) *The Candlepower Distribution Method* in which luminous intensity is measured and luminous flux may be calculated.

2. Lamps for Testing

The scope of this guide covers only the measurement of a lamp or test sample of lamps. The statistical relationship between the sample and the lot of production from which it is taken and methods of sampling to improve this relationship are discussed in the "Manual for Presentation of Data," published by the American Society for Testing Materials.

3. Test Conditions

3.1—*Stray Light*—Adequate precautions should be taken to eliminate stray light from the test set-up.

3.2—*Lamp Stabilization* — (a) Before any measurements are taken, the lamp should be operated until the performance characteristics are stable.

(b) If lamps are warmed up on one ballast and then transferred, without being extinguished, to a different ballast for measurement, an additional period of burning in the measurement circuit is usually necessary to bring the lamp to equilibrium. The length of the additional buring period can be kept to a minimum by using the same lamp loading in both cases.

3.3—*Ambient Temperature* — The ambient in which lamp measurements are being taken should be maintained at 25C±1C, and drafts should be avoided. This temperature should be measured at a point not more than five feet from the lamp and at the same height as the lamp. If the ambient temperature deviates from 25C by more than 1C, it should be so stated in the test report. If temperature corrections are applied, the correction factor should be stated in the report. If a lamp is operated within an enclosure, the air temperature within the enclosure becomes the ambient.

3.4—*Electrical Circuits* — Accurate measurements of light require that the lamp be operated in an appropriate electrical circuit as outlined in the "I.E.S. Guide for Electrical Measurements of Mercury Vapor Lamps."[1]

4. Test Apparatus

4.1—*Photometers*

4.1.1—*Integrating Sphere Photometer*

—(a) In general the length of a straight lamp under test should not be greater than 85 per cent of the inside diameter of the sphere. The area of the light source should not exceed two per cent of the interior surface of the sphere. Departures from these restrictions will have little effect if a strict substitution method is employed.

(b) Lamps should be mounted in the sphere with precautions taken to prevent supports or other adjacent objects from obstructing and absorbing light or affecting the lamp temperature. Precautions should be taken regarding the placement of baffles and to assure proper diffusion at internal painted surfaces. The combined spectral response of the light receiver, filters, sphere window and the sphere as an integrator will have a definite influence on the results that are obtained.

Approved by the Council of the Illuminating Engineering Society, December, 1958. A Transaction of the I.E.S.

4.1.2—*Candlepower Distribution Photometer* — (a) The lamp should be mounted in open air, with precautions taken to prevent supports or other adjacent objects from reflecting light or affecting the lamp temperature.

(b) The distance between the test lamp and the light receiver should be at least five times the lamp length. For compact sources, a minimum of ten feet is recommended.

4.2—*Barrier-Layer Cells* — Barrier-layer cells should be selected and calibrated to determine their spectral response, linearity and fatigue characteristics within the range of values used in the test.

4.3—*Standard Lamps* — (a) While mercury standard lamps are not as stable in their performance as incandescent filament standards, they allow use of a direct substitution method. Thus, both standard and test lamps may be similar in color, response to temperature changes, physical dimensions and light distribution.

(b) The luminous flux of incandescent filament type lumen standards remains susbtantially constant for repeated operation and variations in temperature. However, the difference between their spectral distribution and that of mercury lamps makes it necessary to exercise extraordinary care in the design, maintenance and use of photometric equipment to avoid selective spectral absorption that would alter the finally observed radiation with resultant inaccuracies in measurements of luminous flux.

5. Test Procedures

5.1—*Calibration*

5.1.1—*General*—The test set-up should be calibrated at suitable time intervals to assure accuracy of results. Generally at least three lumen or candlepower standard lamps are used at each calibration. Lumen standards should have approximately the same color and light output as that of the lamp being tested.

5.1.2—*Integrating Sphere Photometer*

5.1.2.1—*General*—(a) In calibrating, the substitution method is employed with either incandescent filament or mercury lumen standards.

(b) If the standard and test source involved are unlike in general size or self-absorption, it is desirable to determine a correction by using the differential self-absorption method described in Section 5.7.

5.1.2.2—*Lamp Operating with Magnet* —When a magnet is used in conjunction with a mercury lamp, the calibration requires that the presence of the magnet be cancelled out of the photometry of the lamp. This can be done by placing the magnet in the sphere with the standard lamps as well as with the test lamp, in the same position with respect to the lamp, but not energized electrically. The standards must of course be of the same type as the test lamp.

5.1.3—*Candlepower Distribution Photometers* — Distribution photometers, when equipped with physical type light receivers corrected to have a response approximating the spectral luminous efficiency curve, may be calibrated against incandescent filament candlepower standard lamps.

5.2—*Color Correction* — When visual photometric methods are used and color differences exist between the standard lamps and the test lamps, the color differences should be minimized. When filters are used for color correction, proper allowance should be made for their absorption. When physical photometric methods are used, and color differences exist between standard lamps and test lamps, a true calibration can be obtained only when the spectral response of the photometric system corresponds to the spectral luminous efficiency curve. For information regarding the correction for spectral differences between photometric standards and test sources, because of deviations of the physical receiver systems' spectral response from the spectral luminous efficiency curve, the reader is referred to the references.[2]

5.3—*Electrical Measurements*—Electrical characteristics of each lamp under test should be measured immediately before or after photometric measurements are made.

5.4—*Electrical Conditions*—Photometric measurements should be made with lamps operating as described in the "I.E.S. Guide for Electrical Measurements of Mercury Vapor Lamps."[1] All instruments, except the one indicating lamp wattage or line voltage (whichever is appropriate), should be out of the circuit. This restriction does not apply to instrument series elements included as a part of the standard reactor impedance.

5.5—*Luminous Flux Measurements*

5.5.1—*General*—The operating position of the test lamp in the sphere should be as specified in Section 6 of the "I.E.S. Guide for Electrical Measurements of Mercury Vapor Lamps."[1]

5.5.2—*Lamp Operating with Magnet*— After the sphere has been calibrated in accordance with 5.1.2.2, the test lamp should be substituted in the desired operating position.

5.5.3—*Ambient Temperature*—In order that the heat of a lamp operating in an integrating enclosure may not raise the temperature above the desired value, the sphere should be closed only long enough to make the measurements.

5.6—*Candlepower Distribution Measurements*

5.6.1.—*General*—(a) Sufficient readings should be taken to allow proper evaluation of the candlepower distribution and total lumen output.

(b) The operating position of the test lamp on the distribution photometer should be as specified in Section 6 of the "I.E.S. Guide for Electrical Measurements of Mercury Vapor Lamps."[1]

5.6.2—*Lamp Operating with Magnet —Subtractive Method*—The distribution curve may be obtained with the lamp operating vertically, both with and without the physical presence of the magnet, but without having the magnet electrically in the circuit. The subtraction figures can then be applied to remove the effect of the presence of the magnet when the lamp is operated in other than the vertical position, and measured under those conditions.

5.7—*Differential Self-Absorption Method*—This is accomplished by providing a very stable light source at some point in the sphere remote from the center. The standard or test source will be located at the center. This separate source should be baffled so that no radiation from it can fall directly on the measurement window, the test source or the luminous flux standard, when either of these lamps is in position for measurement or calibration. With the separate source lighted, the measurement-window brightness is observed with only the luminous flux standard in position but unlighted, and

again with only the test source in position but unlighted. Equality in the two observations indicates that self-absorption of the two sources involved is equal, and no correction is needed. If they are not equal, the calibration by the standard or the observation of the test source must be corrected appropriately by the ratio of the two observations of absorption.

6. Computation of Test Results

6.1—*Integrating Sphere* — Light output of lamps under test may be established by the ratio of the readings between the lumen standard and each test lamp. For possible correction to be applied, see Sections 5.1.2.1 and 5.1.2.2.

6.2—*Candlepower Distribution* —**(a)** Candlepower values of lamps under test may be established by multiplying test readings by the photometer calibration constant determined in 5.1.3.

(b) For possible corrections to be applied, see Section 5.6.2.

(c) Total light output of lamps under test may be established by multiplying candlepower values by appropriate zonal lumen constants and summing.

7. Test Report

The test report should list all significant data for each lamp tested, together with performance data. The report should also list all pertinent data concerning conditions of testing, type of equpiment and type of standard. Typical items that may be included are:

(a) Manufacturer's name and lamp designation;[4] also number of lamps tested.

(b) Purpose of test.

(c) Rated electrical values of lamp type.

(d) Number of hours of operation and operating cycle.

(e) Ambient temperature and temperature correction factor, if any.

(f) Lamp position during test.

(g) Description of magnet and orientation with lamp.

(h) Type of standard lamp used.

(i) Photometric method.

(j) Sphere diameter and/or test distance.

(k) Circuit conditions and fixed parameters.

(l) Measured light output, light intensity and electrical values (volts, amperes, watts) of test lamp.

(m) Date and testing agency.

References

1. Committee on Testing Procedures for Illumination Characteristics: "I.E.S. Guide for Electrical Measurements of Mercury Vapor Lamps," ILLUMINATING ENGINEERING, Vol. LI, No. 8, pp. 597-599 (August 1956).

2. Gabriel, M. H., Koenig, C. P., Steeb, E. S. Jr.: "Photometry, Parts I and II," *GE Review* (September and October 1951).

3. Committee on Testing Procedures for Illumination Characteristics: "I.E.S. General Guide to Photometry, ILLUMINATING ENGINEERING, Vol. L, No. 3, pp. 147-152; No. 4, pp. 201-210 (March and April 1955).

4. *American Standard Method for the Designation of Mercury Lamps*, C78.380-1957, American Standards Association, New York, N. Y. (1957).

Discussion of Conference Papers

Discussion of papers presented at technical sessions of the San Francisco Conference should be submitted for publication with the paper in ILLUMINATING ENGINEERING.

SEND: One copy (original) to Miss Ruby Redford, Editor, ILLUMINATING ENGINEERING, 1860 Broadway, New York 23, N. Y.

One copy to F. W. Sell, Chairman, Papers Committee, Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

One copy to the author of the paper.

One copy to Discussion Organizer of the session. See listing below.

Paper No.	Discussion Organizer
1, 2, 3, 4, 5	John Haney, Crouse-Hinds Co., Wolf & 7th North Sts., Syracuse, N. Y.
6, 7, 8	O. F. Wenzler, Libbey-Owens-Ford Glass Co., 608 Madison Ave., Toledo 3, Ohio.
9, 10, 39	J. J. Neidhart, The Miller Co., Meriden, Conn.
12, 13, 15, 21, 32	A. W. Weeks, Champion Lamp Works, 330 Lynnway, Lynn, Mass.
17, 18, 20, 36, 38	George Gilleard, Curtis-AllBrite Lighting, Inc., 6135 W. 65th St., Chicago 38, Ill.
22, 23, 24	J. N. Robertson, Los Angeles Dept. of Water & Power, Box 3669, Terminal Annex, Los Angeles 54, Calif.
14, 16, 35, 37	A. B. Winters, Revere Electric Mfg. Co., 7420 Lehigh, Chicago 48, Ill.
25, 26, 27, 28, 29	R. E. Dahlin, Southern California Edison Co., Box 351, Los Angeles 53, Calif.
19, 30, 31, 33, 34	M. H. Kruger, Smitheraft Corp., Chelsea, Mass.

IES Council—1959-1960

The Council of the Illuminating Engineering Society is composed of the President, First and Second Vice-Presidents, General Secretary, Treasurer, two Past-Presidents, six Directors, and the eleven Regional Vice-Presidents, whose photographs are on the facing page.

Joseph B. Browder
President

Richard G. Slauer
Vice-President

James R. Chambers
Vice-President

G. Franklin Dean
General Secretary

W. P. Lowell, Jr.
Treasurer

Kirk M. Reid
Past-President

George J. Taylor
Past-President

Charles L. Amick
Director

J. Samuel Hamel
Director

J. Dixon Mitchell
Director

Ray P. Teele
Director

Joseph Thomas
Director

J. D. Whitnell
Director

Regional Vice-Presidents

In addition to serving on Council, IES Regional Vice-Presidents have many duties in their own Regions, assisting Sections and Chapters. They also provide general guidance for the Regional Conferences. Dates and locations for the 1960 Regional Conferences are listed below.

John M. Chorlton
Canadian
Conference: June 13-14
Nova Scotian Hotel
Halifax, N. S.

Carman D. Miller
East Central
No Conference since Region is host to National Technical Conference

Robert W. Brown
Great Lakes
Conference: May 16-17
Hotel Carter
Cleveland, Ohio

Lloyd S. Reed
Inter-Mountain
Conference: April 28-29
Hotel Westward Ho
Phoenix, Ariz.

Brooks Chassaing
Midwestern
Conference: May 12-13
Sheraton-Martin Hotel
Sioux City, Ia.

Raymond L. Smart
Northeastern
Conference: June 8-9
Wentworth-by-the-Sea
Portsmouth, N. H.

Beverly A. Travis
Pacific Northwest
Conference: May 9-10
Benjamin Franklin Hotel
Seattle, Wash.

Jacob M. Gensburger
South Central
Conference: April 21-22
Hotel Peabody
Memphis, Tenn.

Cecil L. Cannon
Southeastern
Conference: April 21-22
Hotel Peabody
Memphis, Tenn.

James E. Barnes
South Pacific Coast
Conference: May 4-6
Ambassador Hotel
Los Angeles, Calif.

John B. Deck, Jr.
Southwestern
Conference: April 25-26
Robert Driscoll Hotel
Corpus Christi, Texas

I.E.S. Section and Chapter

K. L. Cotton
Alamo Section
Southwestern Region

R. W. Godemann
Arizona Section
Inter-Mountain Region

W. R. Simpson
Arkansas Chapter
South Central Region

R. D. Madden
Ark-La-Tex Chapter
Southwestern Region

J. R. Adams
Arrowhead Chapter
South Pacific Coast Region

H. G. Foster
British Columbia Section
Pacific Northwest Region

B. D. Russell
Buckeye Chapter
Great Lakes Region

E. F. Bailer
Capital Section
East Central Region

Lowry Miller
Central Florida Chapter
Southeastern Region

Carl Green
Central Kansas Chapter
Midwestern Region

Robert Caryl
Central N. Y. Section
Great Lakes Region

R. B. Gow
Central Oklahoma Chapter
Southwestern Region

B. F. Avery
Chicago Section
Midwestern Region

William Warrack
Chinook Chapter
Pacific Northwest Region

L. H. Kindel
Coastal Bend Chapter
Southwestern Region

Chairmen—1959-1960

L. L. Black
Coastal Empire Chapter
Southeastern Region

W. P. Carpenter
Connecticut Section
Northeastern Region

H. J. Palmer, Jr.
Cornhusker Section
Midwestern Region

J. M. Harney
Eastern New York Section
Northeastern Region

D. A. Tucker
Edmonton Section
Pacific Northwest Region

K. D. Brumbaugh
Florida Section
Southeastern Region

W. H. Dodd
Forest City Chapter
Canadian Region

S. J. Andre
Georgia Section
Southeastern Region

W. G. Bayha
Golden Gate Section
South Pacific Coast Region

L. H. Ritenberg
Golden West Chapter
Pacific Northwest Region

R. W. Wilson
Heart of America Section
Midwestern Region

A. S. Coffin, Jr.
Indiana Section
Midwestern Region

H. R. Lobdel
Inland Empire Chapter
Pacific Northwest Region

Mary E. Stafford
Iowa Section
Midwestern Region

J. D. Smith
Maryland Section
East Central Region

I.E.S. Section and Chapter

G. A. Grier
Miami Valley Section
Great Lakes Region

E. W. Pratt
Michigan Section
Great Lakes Region

R. J. Present
Milwaukee Section
Midwestern Region

C. E. Strahan, Jr.
Mississippi Chapter
South Central Region

J. E. Shepherd
Montreal Section
Canadian Region

E. E. Storrs
Mother Lode Chapter
South Pacific Coast Region

R. E. Smith
New England Section
Northeastern Region

J. F. MacDougall
New Jersey Section
Northeastern Region

G. J. Segel
New Orleans Section
South Central Region

W. H. Keen
New York Section
Northeastern Region

P. A. Crick
North Texas Section
Southwestern Region

H. W. Teele, Jr.
Northwestern Ohio
Section
Great Lakes Region

F. B. MacRae
Ohio Valley Section
Great Lakes Region

Richard Almond
Oil Capital Section
Southwestern Region

J. A. Schulter
Oregon Section
Pacific Northwest
Region

Chairmen—1959-1960

A. D. Miller
Ottawa Section
Canadian Region

R. L. Adams
Palmetto Section
Southeastern Region

W. P. Graham
Philadelphia Section
East Central Region

D. C. Thomas
Pittsburgh Section
East Central Region

J. H. Wells
Puget Sound Section
Pacific Northwest Region

H. S. Glick
Rochester Section
Great Lakes Region

G. H. Patterson
Rocky Mountain Section
Inter-Mountain Region

Willis Mangold
St. Louis Section
Midwestern Region

J. P. Morin
St. Maurice Valley Chapter
Canadian Region

E. L. Peterson
San Diego Section
South Pacific Coast Region

George Smedberg
San Jose Chapter
South Pacific Coast Region

F. E. Yanaros
Southeast Florida Section
Southeastern Region

B. J. Hartmann
Southern California Section
South Pacific Coast Region

N. A. Gleason
Suwannee River Chapter
Southeastern Region

T. Llew Cordle
Tar Heel Section
Southeastern Region

Section and Chapter Chairmen *(Continued)*

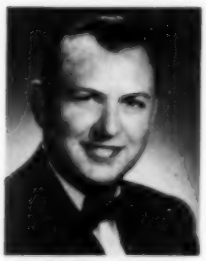
J. R. Harrell
Tennessee Valley Section
South Central Region

R. P. Lindsay
Toronto Section
Canadian Region

J. C. Newhouse
Twin City Section
Midwestern Region

T. A. Gunderson
Twin Ports Chapter
Midwestern Region

J. H. Shaw
Utah Section
Inter-Mountain Region



L. L. Nurnberger
Western Michigan Section
Great Lakes Region

T. E. Barhite, Jr.
Western New York Section
Great Lakes Region

A. C. Burnard
Winnipeg Chapter
Canadian Region

F. P. Hayden
Yankee Section
Northeastern Region

D. E. Fisher
Yosemite Chapter
South Pacific Coast Region

And These . . .

of whom photographs were not available in time for publication.

Alabama Section—M. R. Hazzard
Bluenose Chapter—W. J. Phillips
Central Illinois Chapter—H. G. Young
Cleveland Section—J. G. Mitchell
East Bay Section—Grant N. Radford
Maritime Chapter—E. J. Wilcox
Mid-South Chapter—M. E. Broom
New Mexico Chapter—Olen Peddy
Ozark Chapter—Harold Stahl
Panhandle Chapter—Gordon Baldry
San Jacinto Section—Richard C. Jung
Southern Colorado Chapter—K. J. Stines
South Plains Chapter—R. A. Trawick
Vancouver Island Chapter—Thomas Mawson
Virginia Section—Warren G. Cornelius

Chairmen of the Eastern Pennsylvania Section, Hamilton, Ont. Chapter, Mexico Chapter and Quebec Chapter have not yet been elected.

LIGHTING NEWS

New Appointments To Fill Council Vacancies

The resignation of two officers elected last spring for the 1959-1960 administration, C. W. McCormick, General Secretary, and A. H. Mendel, Canadian Regional Vice-President, necessitated the following appointments by Council at its September 11 meeting in San Francisco.

G. Franklin Dean, Toronto Hydro-Electric System, Toronto, Ont., elected as Treasurer, has been appointed to the position of General Secretary.

W. P. Lowell, Jr., Sylvania Electric Products, Inc., Salem, Mass., elected as a Director, will serve as Treasurer.

Charles L. Amick, Day-Brite Lighting, Inc., St. Louis, Mo., has been newly appointed to Council as Director until 1962.

John M. Chorlton, Toronto Board of Education, Toronto, Ont., was named to the office of Canadian Regional, Vice-President until 1961. Mr. Chorlton is also a new member of Council.

It is the policy of the Society that vacancies which arise on Council, after the general election in May, shall be filled by vote of the Council.

Council Grants Charter To Section No. 89

For the second time in the history of IES, a new local group has been formed with Section status. Latest addition to the IES is the East Bay Section, No. 89, in Oakland, Calif. Eighty-five members transferring from the Golden Gate Section in San Francisco, Calif., will form the nucleus of the new group. Petition for Charter by the new Section was made by South Pacific Coast Regional V-P, James E. Barnes, at the September 11 meeting of Council in San Francisco.

Grant E. Radford, Pacific Gas & Electric Co., Oakland, is Chairman of East Bay Section, with Leonard Komor, Sylvania Electric Products, Inc., Burlingame, Vice-Chairman; Walker Brown, Weld-Rite Co., Oakland, Secretary; and Claude E. Parker, Pacific Gas & Electric Co., Oakland, Treasurer. According to Mr. Radford, the Section is planning to petition Council for permission to change its name to Diabolo Section after Mt. Diabolo, Calif.

The formation of the New Jersey Section in October 1958 was the first time in Society history that a group began its existence as a Section. The New Jersey Section was formed as a result of a vote by the membership of the New York Section, to split that group.

Program Expansion Planned by Fluorescent Lighting Group

The Fuorescent Lighting Association, trade association for the cold-cathode industry, has announced a new promotion campaign to expand its membership services. The Association has moved its offices to new quarters at 230 Park Ave., New York, and has appointed the public relations firm of Monroe B. Scharff & Co., New York, to handle the campaign.

According to Harry Weiss, President of the Association, the expansion program involves the development of an Information Bureau for the dissemination of material on the latest cold cathode lamp products, new equipment, installations and technical data. The Association's Technical Committee will develop technical data and standards information.

Also announced by the group were plans for expansion of membership in the United States and abroad.

Traveling Science Library Developed for Elementary Schools

A circulating library of 100 carefully selected books on science and mathematics, for children in the first to sixth grades, is being made available to 100 elementary schools this year by the American Association for the Advancement of Science. The new project will be operated concurrently with the Association's very successful traveling high school science library program, which has been in operation for five years.

Prime impetus for the organization of the elementary school project came from the results of studies on the winners of the National Science Fairs and Westinghouse Talent Searches. Indications from the studies were that these budding scientists had developed their scientific interests by the time they had entered the sixth grade.

Technical Committee Forum Scheduled October 29-30

Chairmen of all IES technical committees will convene in Wheeling, West Va., October 29 and 30 for a two-day round-table discussion of the Blackwell Report. Under the direction of R. G. Slauer, National First Vice-President and C. L. Crouch, Technical Director, the Technical

(*Continued on page* 8A)

January 30 Is Deadline For 1960 Conference Paper Outlines

Outlines for proposed papers for the 1960 National Technical Conference must be submitted by January 30, 1960 to receive consideration by the Papers Committee. Outlines should be sent to:

Floyd W. Sell, Chairman, IES Papers Committee
The Detroit Edison Co.
2000 Second Avenue
Detroit 26, Michigan

COMMITTEE members for the First Lighting Exposition, to be held in conjunction with the Tenth Biennial Electrical Industry Show in Los Angeles. Left to right: Robert Clubley, industrial lighting division chairman; James D. Bond, office lighting chairman; Urban Beh, general chairman of the Lighting Exposition and Bill F. Jones, chairman of the school lighting section. The Exposition will take place March 23-26.

(Continued from page 7A)

Committee Forum will study methods of disseminating practical information on this subject to those committees most affected by the IERI research on illumination levels.

The subject of good technical meetings for IES Sections and Chapters will also be studied during the two-day Forum sessions. Practical "how-to" suggestions may develop from this study, for the guidance of Section and Chapter programs for good technical meetings, whether interpreting and reporting lighting research or covering other lighting subjects.

Reservations for and information on the Technical Committee Forum may be obtained from C. L. Crouch, IES Headquarters, 1860 Broadway, New York 23, N. Y.

Appliance Sales Course Available from EEI

The Sales Division of the Edison Electric Institute has announced the availability of a new five-part electric appliance sales training course. Included in the course is a section on basic selling principles, presenting a review of the basic tenets of salesmanship as developed in previous successful sales courses given by EEI. Other sections deal with selling of specific products: electric ranges, dryers, water heaters and refrigerator-freezers.

The five-part course is contained in an easel carrying case and comes with a set of 50 charts—ten for each of the above-mentioned subjects; ten pocket-size salesman's manuals for each subject; five leader's guides; 2 acetate "blackboards" and a storage container. Cost of the complete course is $99.50, FOB. Descriptive brochures may be obtained from, and orders placed with: Sales Division, Edison Electric Institute, 750 Third Ave., New York 17, N. Y.

Electrical Show/Lighting Exposition Scheduled for Los Angeles

Plans for a Lighting Exposition to be held in conjunction with the Tenth Biennial Electrical Industry Show, sponsored by the Electrical Maintenance Engineers of Southern California, have recently been announced. The show and exposition are scheduled for March 23-26, 1960 at the Shrine Exposition Hall in Los Angeles.

Urban Beh, consulting lighting engineer of Newport Beach, Calif., heads the committee for the lighting exposition, which counts among its members Roy H. Kreyser, Los Angeles Dept. of Water & Power; Robert Clubley, General Electric Lamp Dept.; Jerry Silbers, Globe Illumination Co.; Bill F. Jones, Smoot Holman Co.; James D. Bond, Lighting Dynamics and John A. Kresich, Steber Manufacturing Co.

Among the exhibits planned for the exposition are lighting of offices, parks, building exteriors, improved classroom lighting, traffic control in stores through illumination and reduction of highway hazards by proper placement of adequate illumination. Special features planned by the committee are side-by-side examples of good and bad lighting for the same area.

The Electrical Industry Show will feature the latest developments in aircraft, automotive, atomic, chemical, rubber, communications, electrical manufacturing and other industries. Robert Marcum, Hughes Aircraft Co. and Charles H. Hays, Electrical Estimators, Inc. are co-chairmen of the event.

Invitations to the exposition and show are being sent to illuminating engineers in 13 Western states, including Alaska and Hawaii.

Interim Guide Available For School Lighting Practice

In response to many requests received by IES for information regarding the Society's position on school lighting, an interim guide to school lighting practice has been prepared and is now available. The guide is composed of excerpts from several sections of the recently published Third Edition of the *IES Lighting Handbook*, and is complete with illustrations and a table of recommended levels of illumination.

The interim guide is in multi-lithed form and single copies may be secured, without charge, from the Technical Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y. Quantity prices are available on request.

A new "Guide for School Lighting," to replace the 1948 *American Standard Practice of School Lighting*, is now being prepared by a Task Committee representing the School Lighting Committees of the American Institute of Architects, National Council for School House Construction and Illuminating Engineering Society. It is expected that this new Guide will be available sometime in 1960.

New ASA Committee for Computer "Language" Standard

To keep pace with the tremendous growth in the use of computers for machine searching of scientific and technical information, the American Standards Association has organized a committee to study the possibility of establishing a standard coding and indexing system for computers. The new committee will function as a subcommittee of ASA Sectional Committee Z39 on library work and documentation, headed by R. E. Kingery of the New York Public Library.

Announcement of ASA action in this

field was made by Mr. Kingery at the International Conference for Standards on a Common Language for Machine Searching and Translation, held during the week of September 7 in Cleveland. Western Reserve University and the Rand Development Corp. were co-sponsors of the conference.

Aim of the week-long meeting was to exchange information and experience on the possibility of establishing a standard common machine language or compatible languages so that information compiled on different machines will be interchangeable. Without standardization, much of the value of the computers may be lost.

Industrial Building Exposition Scheduled for New York City

From December 12-15, 1960, the New York City Coliseum will be the site of the first annual Industrial Building Exposition and Congress. The show is being sponsored by a group of 28 architects and industrial executives responsible for construction and plant operation, and will be produced by Clapp and Poliak, Inc., N.Y.C. exposition management firm.

The Congress will consider such subjects as planning new construction, financing, modernization of older buildings, new types of construction, layout of equipment and avoidance of maintenance problems. Exhibits, directed toward similar themes, will feature such things as structural products, electrical equipment and employee services.

Three co-chairmen, Albert C. Martin, Martin & Associates, Los Angeles; N. M. Martin, IBM Corp., New York and Clifford S. Strike, F. H. McGraw & Co., Inc., New York, head the board of sponsors for this event.

NBS "Journal of Research" Now Published in Four Parts

As a result of the recent reorganization of the publications program of the National Bureau of Standards, the Bureau's *Journal of Research* has been divided into four separate sections which may be subscribed for separately. The sections are: *Physics and Chemistry* ($4.00 per year, six issues); *Mathematics and Mathematical Physics* ($2.25, four issues); *Engineering and Instrumentation* ($2.25, four issues) and Radio Propagation ($4.00, six issues).

The *Journal of Research* of the National Bureau of Standards is the basic publication through which the Bureau reports its findings to the scientific public. It contains comprehensive research papers giving complete details of Bureau work, including laboratory data, experimental procedures and theoretical and mathematical analyses. With the change in format, effective July 1, the *Journal* will be broadened to include review articles on subjects related to the work of the NBS, abstracts of all of the Bureau's non-periodical publications, abstracts of articles by members of the NBS staff which appeared in technical journals and a listing of all Bureau articles not abstracted, with appropriate reference data.

Editorial appointments made in connection with this reorganization are:

Physics and Chemistry—Editor, U. Fano; Associate Editors, D. D. Wagman, J. M. Richardson.

Mathematics and Mathematical Physics—Editor, C .H. Page; Associate Editors, F. L. Alt, E. L. Crow.

Engineering and Instrumentation—Editor, W. A. Wildhack; Associate Editors, G. F. Montgomery, R. B. Jacobs.

Radio Propagation—Editor, James R. Wait; Associate Editors, T. N. Gautier, J. W. Herbstreit, C. G. Little, A. G.

(Continued on page 12A)

SCHEDULED EVENTS

October 13-15, 1959 — Electrical Progress Show, Convention Hall, Philadelphia, Pa.

October 15-17, 1959 — National Society of Professional Engineers (Fall Meeting), Olympic Hotel, Seattle, Wash.

October 19-20, 1959 — Annual Meeting of the United States National Committee (C.I.E.), Nittany Lion Inn, State College, Pa.

October 19-22, 1959—International Municipal Signal Association, Stardust Hotel, Las Vegas, Nev.

October 20-22, 1959 — Tenth National Conference on Standards, The Sheraton-Cadillac Hotel, Detroit, Mich.

November 2-5, 1959 — Eleventh Exposition of the Air-Conditioning and Refrigeration Industry, Convention Hall, Atlantic City, N. J.

November 9-12, 1959 — National Electric Contractors Association and Fifth National Electrical Exposition, Miami Beach, Fla.

November 9-13, 1959 — National Electrical Manufacturers Association, Traymore Hotel, Atlantic City, N. J.

November 17-19, 1959—Building Research Institute (Fall Conferences), Shoreham Hotel, Washington, D. C.

November 18-20, 1959—National Electric Farm Power Conference, Hotel Westward Ho, Phoenix Ariz.

November 19, 1959—Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

November 29-December 4, 1959 — The American Society of Mechanical Engineers, Chalfonte-Haddon Hall, Atlantic City, N. J.

January 13-15, 1960—The Society of Plastics Engineers, Inc., 16th Annual Technical Conference, The Conrad Hilton Hotel, Chicago, Ill.

January 25-28, 1960—Plant Maintenance Show, Convention Hall, Philadelphia, Pa.

January 31-February 5, 1960—American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

February 11, 1960—Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

February 22-25, 1960—National Rural Electric Cooperative Association (Annual Meeting), St. Louis, Mo.

February 25-26, 1960—Annual National Wiring Sales Conference, Warwick Hotel, Philadelphia, Pa.

March 6-9, 1960—Fifth Electrical Industries Show, New York City Coliseum, New York, N. Y.

March 23-26, 1960—Tenth Electrical Industry Show and Lighting Exposition, Shrine Exposition Hall, Los Angeles, Calif.

April 5-7, 1960—Building Research Institute, Spring Conferences, Statler-Hilton Hotel, New York, N. Y.

April 11-12, 1960—Inter-Society Color Council, Philadelphia Museum College of Art, Philadelphia, Pa.

April 21-22, 1960— South Central—Southeastern Regional Conference, IES, Hotel Peabody, Memphis, Tenn.

April 25-26, 1960—Southwestern Regional Confe ence, IES, Robert Driscoll Hotel, Corpus Christi, Texas.

April 28-29, 1960—Inter-Mountain Regional Conference, IES, Hotel Westward Ho, Phoenix, Ariz.

May 1-5, 1960—National Association of Electrical Distributors, Dallas, Texas.

May 4-5, 1960—South Pacific Coast Regional Conference, IES, Ambassador Hotel, Los Angeles, Calif.

May 9-10, 1960—Pacific Northwest Regional Conference, IES, Benjamin F anklin Hotel, Seattle, Wash.

May 10-12, 1960—American Institute of E' ctrical Engineers (Farm Electrification Conference), Sheraton-Fontenell Hotel, Omaha, Nebr.

May 12-13, 1960—Midwestern Regional Conference, IES, Sheraton Martin Hotel, Sioux City, Ia.

May 16-17, 1960—Great Lakes Regional Conference, IES, Hotel Carter, Cleveland, Ohio.

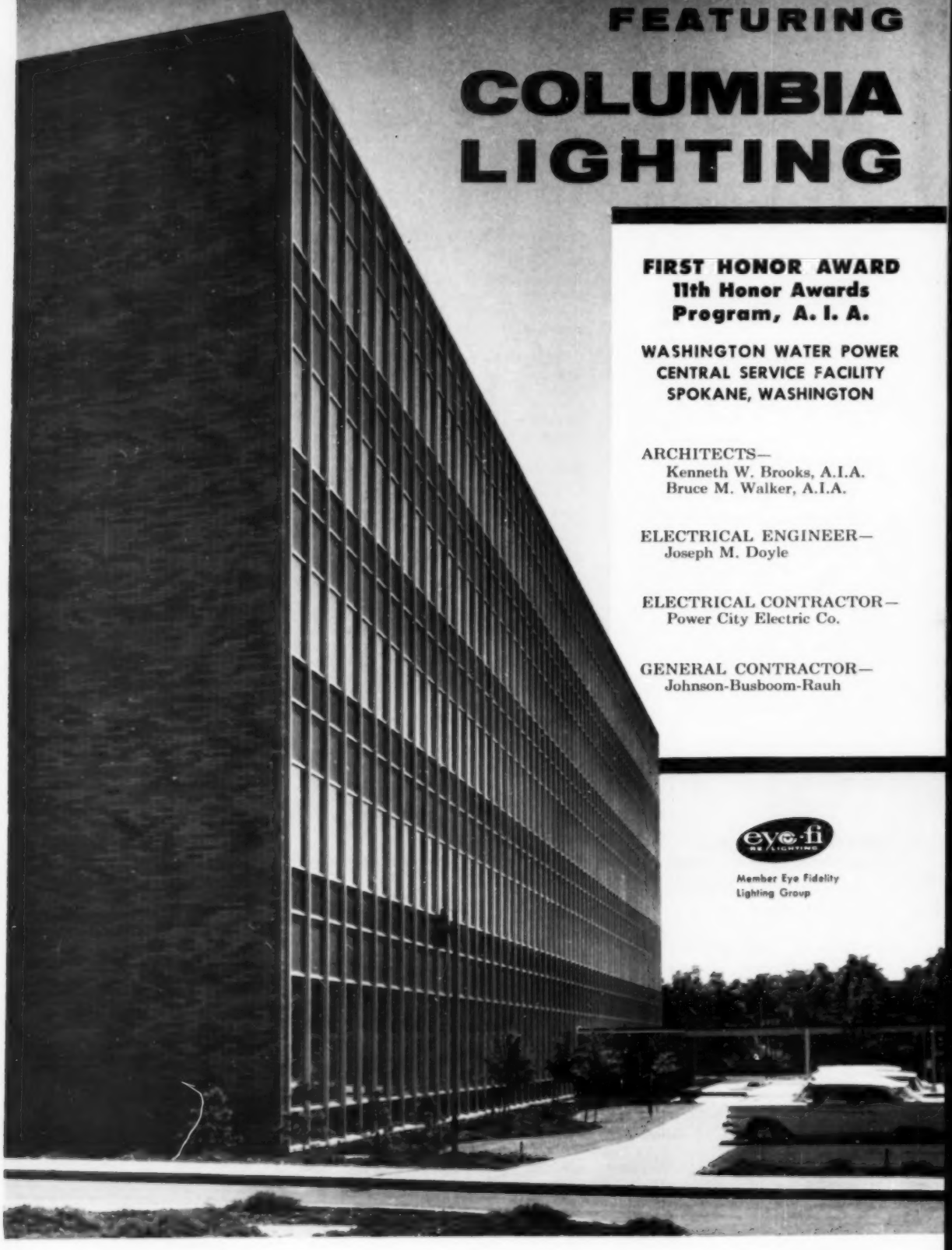
May 23-26, 1960—Design Engineering Show, Coliseum, New York, N. Y.

June 8-9, 1960—Northeastern Regional Conference, IES, Wentworth-by-the-Sea, Po tsmouth, N. H.

June 13-14, 1960—Canadian Regional Conference, IES, Nova Scotian Hotel, Halifax, N. S.

ARCHITECTURAL ACHIEVEMENT FEATURING

COLUMBIA LIGHTING



FIRST HONOR AWARD
11th Honor Awards Program, A. I. A.

WASHINGTON WATER POWER CENTRAL SERVICE FACILITY SPOKANE, WASHINGTON

ARCHITECTS—
Kenneth W. Brooks, A.I.A.
Bruce M. Walker, A.I.A.

ELECTRICAL ENGINEER—
Joseph M. Doyle

ELECTRICAL CONTRACTOR—
Power City Electric Co.

GENERAL CONTRACTOR—
Johnson-Busboom-Rauh

eye·fi RE/LIGHTING

Member Eye Fidelity Lighting Group

Joseph M. Doyle, Electrical Engineer, says, "The specifications for lighting in this building were among the most demanding I have ever written. Cooperation of the engineering department of Columbia Electric through planning and construction stages resulted in an over-all lighting installation that exceeded our expectations."

Raymond Wetherall, Chief System Operator, Washington Water Power, says, "Here in the Control Center of the Washington Water Power, light reaches the ultimate in function. The system map is evenly lighted, top to bottom and side to side . . . literally bathed in light. We had to have it, so Columbia did it."

TROFFER DIFFUSER—CORNING. PATTERN 70

Kinsey Robinson, President, Washington Water Power, says, "In a way, light is the end product of our business. It is only reasonable, then, that lighting design, engineering and fixtures in our new headquarters should be exemplary. Columbia is, in a large measure, responsible for our complete satisfaction."

The Washington Water Power building was no ordinary lighting job. Every step of the way, it was special . . . a new challenge in every room. It's nice to have a part in a building like this . . . a chance to stretch your muscles and give it everything you have. It's nice to apply your engineering skill and production know-how to a job like this and have everyone happy with the result. That, in fact, is the life story of Columbia . . . engineering skill and production know-how combined to make everyone happy with the result.

Please send for our complete catalog today!

COLUMBIA ELECTRIC & MANUFACTURING CO.

Dept. I-10 • 2310 N. Fancher Way, Spokane 10, Wash. • 1315 E. Third St., Los Angeles, Calif.

COLUMBIA ELECTRIC CO., Inc. • 7900 Sovereign Row • Dallas 35, Texas

(Continued from page 9A)

McNish. Advisers from the Institute of Radio Engineers, D. G. Fink, K. M. Siegel.

Orders for the *Journal of Research* should be placed with the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Plant Maintenance Show Philadelphia, January 25-28

Convention Hall, Philadelphia, has been selected as the site for the 1960 Plant Maintenance and Engineering Show, according to a recent announcement by Clapp & Poliak, Inc., New York, N. Y., producers of the event. The show will be held from January 25-28, 1960, with a conference program planned for the first three days.

One of the most important aspects of the exhibits at this exposition will be various products and equipment used for elimination of factory pollution of air and water, a problem of great importance to both management and the community. All exhibits will emphasize cost reduction through preventive maintenance.

This is the first time in four years that the Maintenance Show will be held in the East. Further information and registration cards may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

Extra-High Voltage Cable Under Development at Cornell

A $500,000 grant has been made to Cornell University by the Association of Edison Illuminating Companies, the Edison Electric Institute and various individual public utilities to begin research on the development of an extra-high voltage cable which scientists hope will be capable of carrying enough power to serve a city the size of Grand Rapids, Mich. End result of the research, according to Professor Joseph L. Rosson, director of the project, will be the development of cables with nominal rating for service of 350,000 volts and 500,000,000-volt amperes, bringing more power to the consumer at lower cost.

Construction of the research test station outside Ithaca, N. Y. is underway and will be completed this fall. The field test program is expected to last for about three years and cable systems resulting from the program should be available for general use by 1965.

The cables will be designed for underground transmission because of the increasing difficulty of obtaining easement rights for overhead power lines in metropolitan areas. They will match the voltage and load capabilities of the largest circuits now in use. It is predicted that a city the size of Toledo plus Grand Rapids will be supplied with enough electric power for normal needs through a single circuit consisting of three of the cables now being developed at Cornell.

Estimates indicate that before the research is complete, an excess of $1,500,000 will be spent for the development of specimens, equipment and measurements.

Originally, it was planned to carry out this research at a large company laboratory, but in order to stimulate student interest in public utility research, the sponsors decided to make the grant to a university. Cornell was chosen by a committee of utility engineers after careful study of the advantages offered by various institutions throughout the country.

January 1—Deadline for Gold Medal Nominations

Nominations for the IES Gold Medal, illumination's highest honor, must be received at Society Headquarters by January 1, to be considered for the 1960 award. Any member of the Society may make a nomination by submitting, to the General Secretary, the name of a candidate worthy of this high honor. Field of accomplishment may be engineering, lighting research, optics, applied illumination, ophthalmology, education, design or administration and management. Candidates need not be citizens of the United States or Canada, or members of the Society, to be eligible for the award.

The Gold Medal is awarded "for meritorious achievement which has conspicuously furthered the profession, art or knowledge of illuminating engineering." Presentation of the 1960 Medal, together with an appropriately embossed certificate, will be made during ceremonies at the 1960 National Technical Conference in Pittsburgh.

The Medal Award Committee gives consideration to candidates who have been nominated in previous years, when deciding upon the Medallist.

New York Section Fundamentals Course

With many sucessfully operated "Fundamentals of Illumination" courses behind them, the New York Section of IES began its 1959 version of the 12-week course in basic lighting principles on September 21. Classes meet for two-hour sessions at the General Electric Building in New York City. Text for the course is the Third Edition of the *IES Lighting Handbook*.

E. L. Gluck, McPhilben Lighting, Inc., Brooklyn, N. Y. is coordinator of the course and serving as his faculty are: I. Fishman, Port of New York Authority; L. Goren, Globe Lighting Products; D. R. Lowe, General Electric Co. and R. S. Wissoker, Day-Brite Lighting, Inc.

Program and instructors are:

September 21—Theory of Light—Termi. ology and Measurements—R. S. Wissoker.
September 28—Light Sources I—Filament—D. R. Lowe.
October 5 — Light Sources II — Fluorescent Lamps—D. R. Lowe.
October 14—Light Sources III—Fluorescent and Mercury—D. R. Lowe.
October 19—Control of Light—Methods and Fixture Distributions—E. L. Gluck.
October 26—Calculating Footcandle Levels—Lumen Method; Point by Point Method—E. L. Gluck.
November 2—Quantity and Quality of Illumination (Blackwell Report)—R. Wissoker.
November 9—Design of Interior Lighting Installations (Problem Practice Session—Incandescent and Mercury)—L. Goren.
November 16—Problem Practice Session—Fluorescent—R. Wissoker.
November 23—Problem Practice Session—Luminous Systems—L. Goren.
November 30—Outdoor Lighting—I. Fishman.
December 7—Economics and Maintenance—I. Fishman.

For members of IES, AIA, AIEE and AID the fee for the lighting course is $15; $20 for all others.

Street and Highway Clinic Sponsored by CLI

A full-day clinic on Street and Highway Lighting was held at the Chicago Lighting Institute on September 17. Traffic engineers, consulting engineers, city managers and electrical contractors, as well as lighting engineers were in attendance at the clinic which featured:

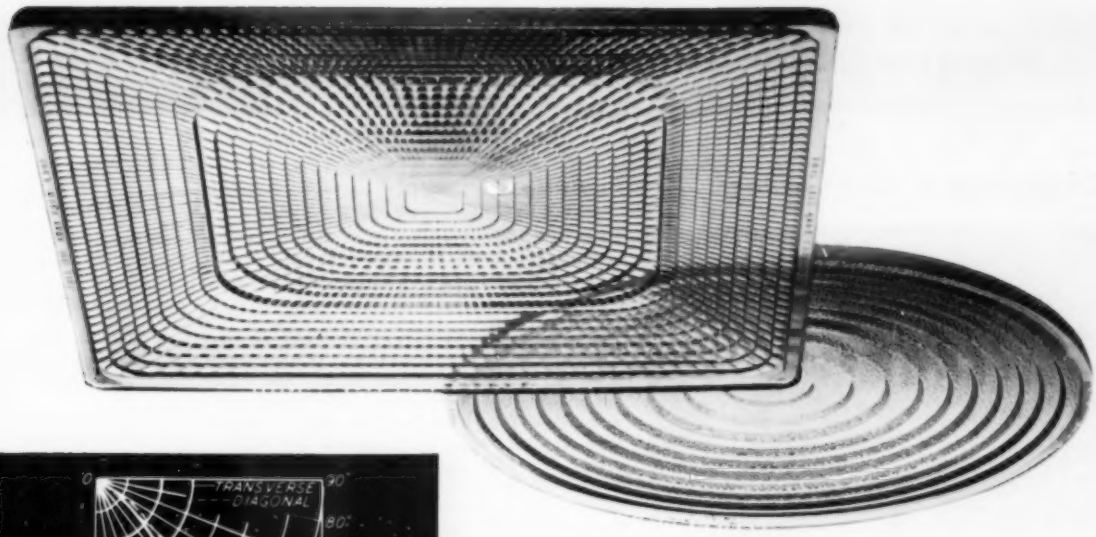
Morning Session

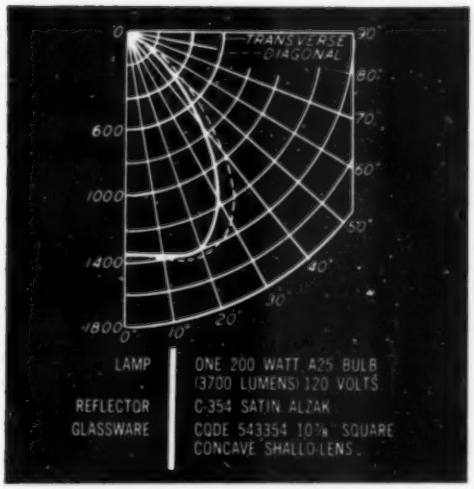
Chairman—L. M. Johnson, Commissioner of Streets & Sanitation, City of Chicago.
Standard Practice for Street and Highway Lighting—M. E. Keck, Westinghouse Electric Corp., Cleveland, Ohio.
Today's Street Lighting: Incandescent, Mercury and Fluorescent—W. E. Schwannhauser, General Electric Co., Hendersonville, N. C.
Light Sources — Ballasts — R. E. Wozniak, Chicago Lighting Institute.
Light Control and Operating Equipment
Lighting Optics—A. R. Jaeger, Corning Glass Works, Corning, N. Y.
Basic Elements of Street Lighting Design—A. W. Lange, Holophane Co., Inc., Chicago, Ill.
Time Clock and Photo-Electric Cells—A. O. Engen, Line Materials Industries, Kansas City, Mo.
Series vs. Parellel Systems—Edward Prims—Commonwealth Edison Co.
Discussion Moderator—B. W. Johnson, City Manager, Evanston, Ill.

Afternoon Session

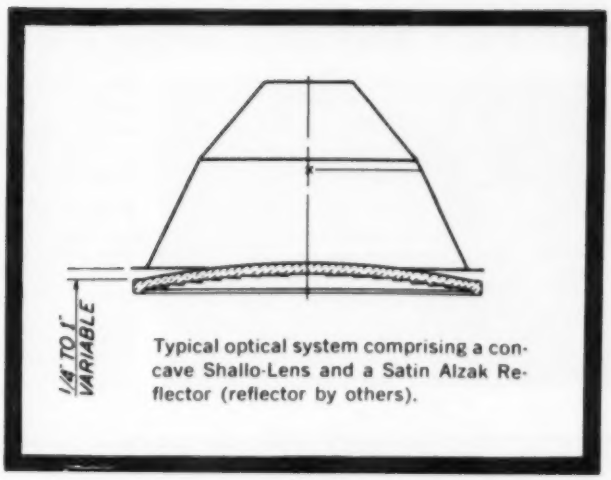
Chairman—B. D. Allison, Electrical Engineer, Northwestern Railroad and Mayor of Elmhurst, Ill.
Types of Pole Equipment
Wood—James Fahey, Jr., Joslyn Mfg. & Supply Co., Chicago, Ill.
Concrete—J. W. Lewis, American Concrete Corp., Chicago, Ill.
Aluminum—T. J. Morgan, Union Metal Mfg. Co., Canton, Ohio.

(Continued on page 15A)





Notice low brightness in critical zones provided by this unique new optical design.



Typical optical system comprising a concave Shallo-Lens and a Satin Alzak Reflector (reflector by others).

New shallow effect can be achieved in incandescent fixtures with PYREX® Shallo-Lens and corresponding Satin Alzak Reflector in boxes six inches or less deep.

New from Corning
PYREX® CONCAVE SHALLO-LENS
for modern-styled incandescent fixtures

Nestled neatly in a mounting box six inches *or even less* in depth, this new Corning Shallo-Lens line can help you achieve with incandescent lighting the modern look in fixture design.

Coupled with a Satin Alzak Reflector, the Shallo-Lens gives you a new measure of uniform general illumination along with high efficiency and utilization.

Square and Round—Added diagonal intensity in the square Shallo-Lens fills in that area between units not normally illuminated by symmetrical distribution. The round design can be specified "Colouvered" for even softer illumination and lower brightness with risers glowing in the color specified.

Heat Resistant—Use this PYREX® heat-resisting glass indoors or out with no fear of breakage from excessive heat or sudden thermal shock.

For complete data on performance and design, write for Bulletin L-121-J. Address your card to Lighting Sales Department, 61 Crystal Street, Corning, N. Y.

CORNING GLASS WORKS

CORNING MEANS RESEARCH IN GLASS

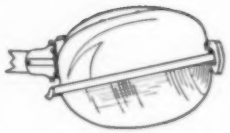
Revere Outdoor Lighting Report

Revere ELECTRIC MFG. CO.

Lighting a city street

The Problem: To illuminate a wide city street uniformly across the total width with high-level light, thus providing fast-moving traffic with utmost visibility for safety.

The Solution: Revere Endoval Luminaires with 400-watt mercury lamps were mounted at 10° tilt on both sides of the wide street, staggered. Distribution pattern selected was I.E.S. Type III which provided uniform light across the entire width of the street, giving the high visibility desired for safe, smooth traffic flow. There is adequate spill light to illuminate sidewalks and parked cars. Endovals mount horizontally if desired.

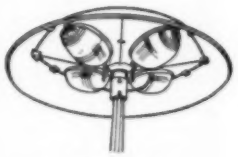


No. 2200 Series
Endoval Luminaire

Lighting a shopping center parking lot

The Problem: To provide high night-visibility for a large shopping center parking lot for ease and safety in driving, parking, and locating parked cars, and to make the shopping center more inviting.

The Solution: High-level, uniform lighting was achieved with 187 Revere 72-inch diameter Ultra-Lites, mounted 34 feet above grade. They use four E-H1 400-watt mercury lamps each, positioned for widest coverage and highest illumination level. Ultra-Lites throw square light patterns which overlap to eliminate "dark spots" and to build up light values in fringe areas.

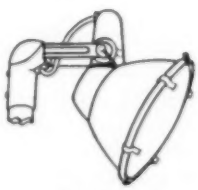


No. 5442 Ultra-Lite

Lighting a flight line

The Problem: To illuminate the wide expanse of a flight line so that routine aircraft operations could be carried on at night with complete convenience and safety.

The Solution: To light the broad flight line intensely and uniformly, 1800 Revere Alzak Aluminum Enclosed Floodlights were used. They were mounted on thirty 80-foot poles, each pole having two banks of 30 floodlights. Each bank has 12 wide-beam floodlights (No. 4211-P) and 18 narrow-beam floodlights (No. 4216-P), with 1500-watt P.S. 52 clear, general-service lamps.



No. 4200
Series Floodlight

Write for Revere's complete catalog of outdoor lighting equipment.

Revere ELECTRIC MFG. CO.

OUTDOOR LIGHTING

Revere Electric Mfg. Co. • 7420 Lehigh Avenue • Chicago 48, Illinois (In suburban Niles)
Long Distance Phone: NIles 7-6060 • Chicago Phone: SPring 4-1200 • Telegrams: WUX Niles
In Canada: Curtis Lighting, Ltd., Leaside, Toronto, Ontario

(*Continued from page* 12A)

Steel—Stanley Starr, Revere Electric Mfg. Co., Chicago, Ill.
Street Lighting and Traffic Safety—Michael Robinson, Deputy City Traffic Engineer, City of Chicago.
Street Lighting and Crime Prevention—Captain Robert Kelleher, Police Dept., City of Chicago.
Maintenance Methods—G. H. Page, Thompson Electric Co., Cleveland, Ohio.
Relamping — Group Replacement — J. W. Young, Consultant to Sylvania Electric Products, Inc., Boston, Mass.
What Lies Ahead in Street and Highway Lighting?—L. M. Johnson, Commission of Streets and Sanitation, City of Chicago, Ill.

Co-sponsoring the Clinic with the Chicago Lighting Institute were the Chicago Association of Commeree and Industry, Chicago Motor Club, Chicago Real Estate Board, Midwest Section — Institute of Traffic Engineers, National Automobile Theft Bureau, Traffic Institute of Northwestern University and the Cook County Highway Department.

Fee for the clinic, including luncheon, was $12.

Lighting Conferences on Schools, Advanced Applications

The lighting education program of the General Electric Lighting Institute in Nela Park, Cleveland, got underway this fall with two conferences—the first on advanced application techniques in commercial and industrial lighting; the second, a school lighting program for school officials.

The five-day meeting on advanced application techniques, held September 20 through October 2, was designed for experienced lighting personnel, to bring them up to date on the latest developments in the illumination field. The program included sessions on new sources, lighting, heating and air conditioning, brightness engineering, high frequency operation of lamps and reports on recent research. "Table Talk" sessions in each of four specific application areas—offices, schools, stores and industry—were designed to develop delegate participation in the conference. These meetings featured presentation of outstanding lighting jobs by delegates.

Among those attending the conference were utility engineers, architects, consulting engineers, plant engineers, equipment sales representative and electrical contractors.

The one-day school lighting conference on October 5 was intended as an aid in the education of school administrators on present-day standards of lighting. Topics covered on this program included seeing and human performance, new and improved lamps, classroom lighting, new design techniques, home study lighting, auditorium and stage lighting, the audio-visual classroom and sports lighting.

ABOUT PEOPLE

Joseph S. Schuchert, for many years an executive with the Duquesne Light Co., Pittsburgh, has resigned his position there to accept the post of Vice-President in charge of sales with the Equitable Gas Co., Pittsburgh. The change was effective August 15. This move necessitated Mr. Schuchert's resignation as Chairman of the Executive Committee of the IES National Technical Conference in Pittsburgh (1960). **Nelson Warner,** Westinghouse Electric Corp., has accepted the chairmanship of the Conference.

Sylvanin Electric Products, Inc., subsidiary of General Telephone and Electronics Corp., has announced the elections of **Leslie H. Warner** as a member of the Board of Directors and **Robert E. Kenoyer** as controller of the company. Mr. Warner, executive vice-president—manufacturing of GT&E succeeds the late **Richard L. Bowditch,** C. H. Sprague & Son Co., Boston, Mass., on the Sylvania Board. Mr. Bowditch died on July 31. Mr. Kenoyer, former controller of Sylvania Home Electronics Division, succeeds **Leon C. Guest, Jr.,** as controller of Sylvania Electric Products. Mr. Guest was recently elected vice-president and general controller of General Telephone & Electronics.

Among some 15 members of the Society of Motion Picture and Television Engineers recently honored by elevation to the grade of Fellow, is IES member **Robert E. Birr,** product planning engineer, General Electric Co., Cleveland. A Fellow of the SMPTE is one who "by his proficiency and contributions has attained outstanding rank among engineers or executives of the motion picture or television industries." Presentation of the Fellow awards took place during the 86th semi-annual convention of the SMPTE, October 5-9, Statler-Hilton Hotel, New York City.

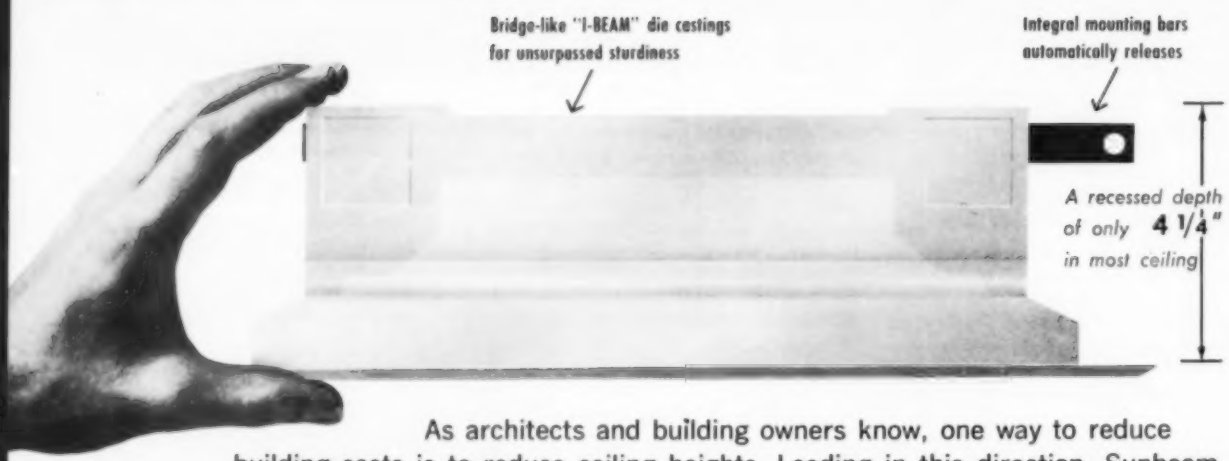
Thomas M. Linville, manager of the Research Operation Department, General Electric Research Laboratory, Schenectady, N. Y., has been named as a member of the National Research Council, to serve until June 30, 1962. He will represent the American Institute of Electrical Engineers in the Council's Division of Engineering and Industrial Research. **Detlev W. Bronk,** president

(*Continued on page* 46A)

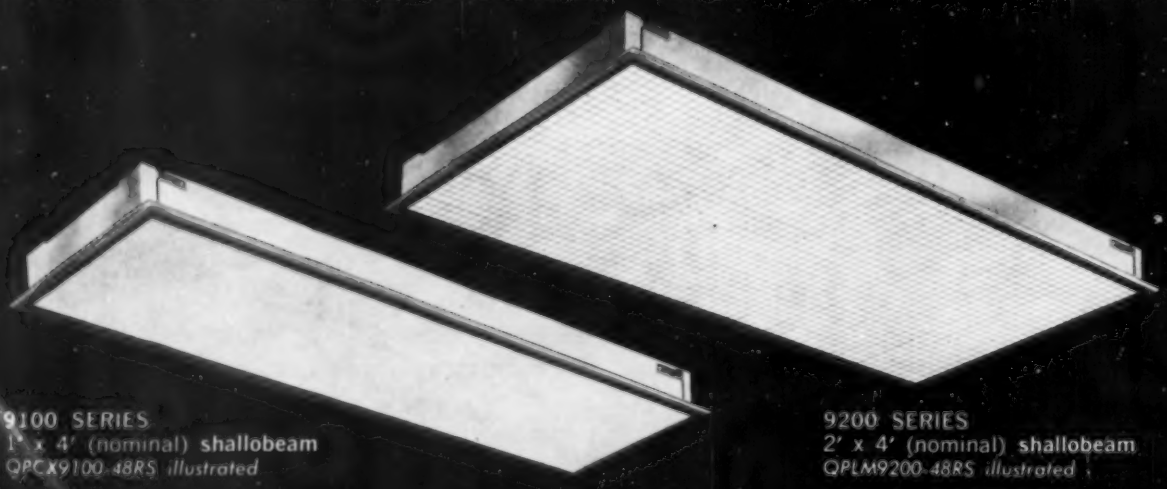
I thought your job was confined to replacing street lights.

Patents pending

NOW IT'S **shallobeam**

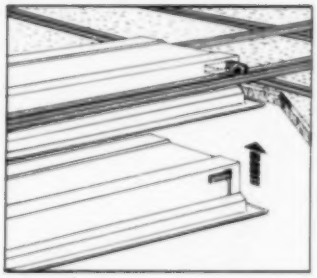

Bridge-like "I-BEAM" die castings for unsurpassed sturdiness
Integral mounting bars automatically releases
A recessed depth of only 4 1/4" in most ceiling

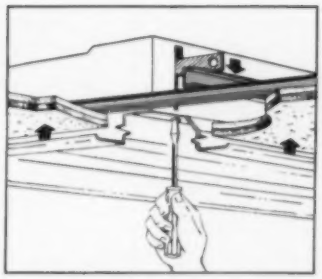
As architects and building owners know, one way to reduce building costs is to reduce ceiling heights. Leading in this direction, Sunbeam Lighting Company now has available a series of ultra-shallow, recessed luminaires — the **shallobeam.** Amazingly compact, these completely integrated "lighting packages" occupy a recessed depth of only 4¼" in most ceilings. Modular in concept, **shallobeam** units of 1′ x 4′, 2′ x 4′, and 4′ x 4′ can be "matched" within a single ceiling plan. Application flexibility is greatly enhanced by the wide variety of light control and diffusing media available. The smartly refined trim with no visible latches give the fixtures a crisp, modern, clean appearance.



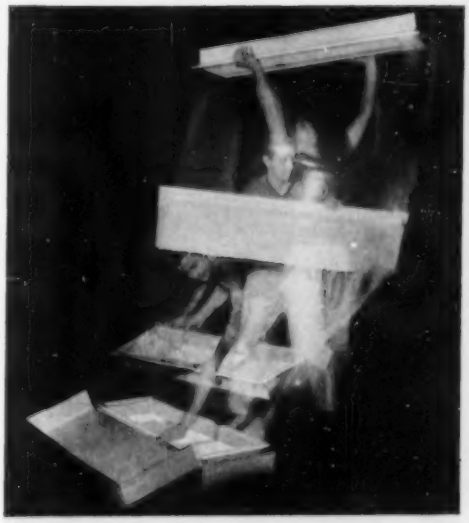
9100 SERIES
1′ x 4′ (nominal) **shallobeam**
QPCX9100-48RS illustrated

9200 SERIES
2′ x 4′ (nominal) **shallobeam**
QPLM9200-48RS illustrated

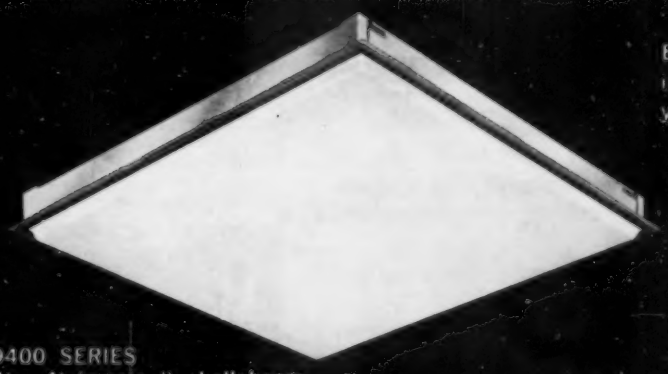




No extra mounting brackets are required. When the **shallobeam** is lifted into the ceiling opening, integral mounting bars automatically trigger into supporting position. The fixture rests bridge-like on the ceiling runners, completely accessible from underneath. Unique "I-Beam" die castings and die-formed parts give **shallobeam** incomparable strength and rigidity and assure precision alignment in continuous rows. A few turns of the leveling device lifts and locks units firmly flush to ceiling.



Specification of shallobeam will be good news to electrical contractors. Many cost-saving factors have been engineered into these units. In one-two-three simplicity, shallobeam can be (1) lifted from carton, (2) snapped into ceiling opening and (3) quickly adjusted and connected.



9400 SERIES
4' x 4' (nominal) **shallobeam**
QSDP9400-48RS illustrated

Be sure to include this latest development in scientifically designed recessed lighting in your plans. Write for bulletin D-99 today.

SUNBEAM visionaire

SUNBEAM LIGHTING COMPANY

777 East 14th Place, Los Angeles, California • 3840 Georgia Street, Gary, Indiana

ABOVE ALL:

LUSTREX PERMA TONE STYRENE LOUVERS!

WHY? 2 to 3 times more resistance to yellowing than general purpose styrene! (Perma tone—specially developed to meet IES-NEMA-SPI joint specifications for ultra violet light-stabilized styrene—exceeds the requirements of these specifications).

WHY? Unlimited translucencies in white and complete color range.

WHY? All the general advantages of styrene in lighting: large area of illumination, good diffusion; light weight for easy handling, installation, and maintenance; good dimensional stability; low cost.

WHY? Proven in use by leading fixture manufacturers, molders, lighting engineers, architects. No formulation modifications since 1956.

For free Technical Report on Lustrex perma tone styrene, including accelerated test results and other valuable data on styrene in lighting, write to Monsanto Chemical Co., Plastics Division, Room 1320, Springfield 2, Mass.

LUSTREX: Reg. U.S. Pat. Off.

Louvers in Lockheed Aircraft Corp. Building, Sunnyvale, Calif. by Day-Brite Lighting, Inc., St. Louis, Mo.

Molded of Lustrex perma tone styrene by K-S-H Plastics, High Ridge, Mo. Electrical Engineers: Keller and Gannon of San Francisco, Calif.; Contractor: Central Electric Co.

Monsanto

I. E. S. National and Local Officers, 1959-1960

Officers and Council 1959-1960

President — J. B. BROWDER, Georgia Power Co., 75 Marietta St., N. W., Atlanta, Ga.
Vice-President — R. G. SLAUER, Sylvania Electric Products, Inc., One 48th St., Wheeling, W. Va.
Vice-President — J. R. CHAMBERS, Appleton Electric Co., 1701-1759 Wellington Ave., Chicago, Ill.
Past-President — G. J. TAYLOR, Day-Brite Lighting, Inc., 122 E. 42nd St., New York, N. Y.
Past-President — K. M. REID, General Electric Co., Nela Park, Cleveland, Ohio.
General Secretary—G. FRANKLIN DEAN, Toronto Hydro-Electric System, 14 Carlton St., Toronto, Ont.
Treasurer—W. P. LOWELL, JR., Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

Directors

CHARLES L. AMICK, Day-Brite Lighting, Inc., P.O. Box 141, St. Louis, Mo.
J. SAMUEL HAMEL, 1122 Rossmoyne St., Glendale, Calif.
J. DIXON MITCHELL, Westinghouse Lamp Division, 2260 Peachtree Industrial Blvd., Chamblee, Ga.
R. P. TEELE, National Bureau of Standards, Washington, D. C.
JOSEPH THOMAS, Canadian General Electric Co., Ltd., 280 Faillon St., Montreal, Que.
J. D. WHITNELL, Arizona Public Service Co., P. O. Box 2591, Phoenix, Ariz.

Regional Vice-Presidents

Canadian Region—JOHN M. CHORLTON, Toronto Board of Education, 155 College St., Toronto 2B, Ont.
East Central Region—C. D. MILLER, Duquesne Light Co., 435 Sixth Ave., Pittsburgh, Pa.
Great Lakes Region — R. W. BROWN, Cincinnati Gas & Electric Co., 4th & Main Sts., Cincinnati, Ohio.
Inter-Mountain Region — L. S. REED, L. S. Reed & Co., 1018 Lawrence, Denver, Colo.
Midwestern Region — BROOKS CHASSAING, Chassaing Brothers Lighting, 7603 Forsyth Blvd., Clayton, Mo.
Northeastern Region — R. L. SMART, Boston Edison Co., 39 Boylston St., Boston, Mass.
Pacific Northwest Region — BEVERLY TRAVIS, 1117 Second Ave. Bldg., Seattle, Wash.
South Central Region — J. M. GENSBURGER, New Orleans Public Sevice, Inc., 317 Baronne St., New Orleans, La.
Southeastern Region — C. L. CANNON, 155 Nassau St., N. W., Atlanta, Ga.
South Pacific Coast Region — J. E. BARNES, Pacific Gas & Electric Co., P. O. Box 540, San Rafael, Calif.
Southwestern Region — JOHN B. DECK, JR., Texas Power & Light Co., P. O. Box 6331, Dallas, Texas.

Section and Chapter Officers 1959-1960

Alabama Section—South Central Region
Chairman — M. R. HAZZARD, Hazzard, McRay & Cone, 3015 Sixth Ave. S., Birmingham, Ala.
Secretary — R. D. STEELE, Alabama Power Co., 2100 1st Ave. N., Birmingham 2, Ala.

Alamo Section—Southwestern Region
Chairman — KENNETH L. COTTON, 434 So. Main Ave., San Antonio, Texas.
Secretary — L. W. TRAVIS, Beretta, Green-Slade & Assoc. Inc., 1927 N. St. Mary's, San Antonio, Texas

Arizona Section—Inter-Mountain Region
Chairman — ROBERT W. GODEMANN, Arizona Public Service Co., P. O. Box 2591, Phoenix, Ariz.
Secretary — WILLIAM BENNDORF, 221 E. Camelback Rd., Phoenix, Ariz.

Arkansas Chapter—South Central Region
Chairman — W. R. SIMPSON, Arkansas Power & Light Co., 123 W. 4th St., Little Rock, Ark.
Secretary — S. J. LAVENDER, Tri-State Mill Supply Co., 224 Mulberry, Pine Bluff, Ark.

Ark-La-Tex Chapter—Southwestern Region
Chairman — R. DON MADDEN, Southwestern Electric Power Co., 428 Travis, Shreveport, La.
Secretary — RALPH P. NIX, 3520 Alexander, Shreveport, La.

Arrowhead Chapter—South Pacific Coast Region
Chairman — J. R. ADAMS, Southern California Edison Co., 577 "D" St., San Bernardino, Calif.
Secretary — G. F. BURGESS, California Electric Power Co., 2885 Foothill Blvd., San Bernardino, Calif.

Bluenose Chapter—Canadian Region
Chairman — W. J. PHILLIPS, 9 Crestview Drive, Armdale, N. S.
Secretary — J. G. FERRARIS, P. O. Box 102, Armdale P. O., Halifax, N. S.

British Columbia Section—Pacific Northwest Region
Chairman—H. G. FOSTER, Northern Electric Co., Ltd., 8325 Fraser St., Vancouver, B. C.
Secretary — W. J. BUTLER, B. C. Electric Co., Ltd., 970 Burrard St., Vancouver, B. C.

Buckeye Chapter—Great Lakes Region
Chairman — B. D. RUSSELL, Columbus & Southern Ohio Electric Co., 215 N. Front St., Columbus, Ohio.
Secretary — M. J. LEAHY, M. J. Leahy Co., 1089 Elmore Ave., Columbus, Ohio.

Capital Section—East Central Region
Chairman—EDMUND F. BAILER, 3518 Farthing Drive, Silver Spring, Md.
Secretary — C. E. O'DANIEL, Potomac Electric Power Co., 929 E. St., N. W., Washington, D. C.

Central Florida Chapter—Southeastern Region
Chairman — LOWRY MILLER, 515 Park Ave., South, Winter Park, Fla.
Secretary — LEE STUHL, 1616 Dumont St., Orlando, Fla.

Central Illinois Chapter—Midwestern Region
Chairman — H. G. YOUNG, Kiefer Electrical Supply Co., 318-320 S. W. Washington, Peoria, Ill.
Secretary — ROBERT J. ZUCKER, Westinghouse Electric Corp., 4910 Melody Lane, Peoria, Ill.

Central Kansas Chapter—Midwestern Region
Chairman — CARL GREEN, Carl Green & Associates, 1542 S. St. Francis, Wichita, Kans.
Secretary — FRANK EDDINS, Kansas Gas & Electric Co., P. O. Box 208, Wichita, Kans.

Central New York Section—Great Lakes Region
Chairman — ROBERT CARYL, Dixon Drive, Solvoy, N. Y.
Secretary — DONALD R. BROWN, Crouse-Hinds Co., Wolf & 7th N. St., Syracuse, N. Y.

Central Oklahoma Chapter—Southwestern Region
Chairman — ROBERT B. GOW, Oklahoma Gas & Electric Co., 321 N. Harney St., Oklahoma City, Okla.
Secretary—GRANT K. LANDON, Oklahoma City Board of Education, 900 N. Klein, Oklahoma City, Okla.

Chicago Section—Midwestern Region
Chairman — BENJAMIN F. AVERY, General Electric Co., 165 N. Canal St., Chicago, Ill.
Secretary — ELDON H. WITTE, Benjamin Electric Mfg. Co., Des Plaines, Ill.

Chinook Chapter—Pacific Northwest Region
Chairman — W. WARRACK, Warrack Electric, 814 16th Ave., N. W., Calgary, Alta.
Secretary — NIELS JOHANSEN, J. Stevelson & Associates, 344 12th Ave., S. W., Calgary, Alta.

Cleveland Section—Great Lakes Region
Chairman—J. G. MITCHELL, Grant Electric Co., 3016 Payne Ave., Cleveland, Ohio.
Secretary — L. S. STERNBERG, Midland Electric Co., 2125 Superior Ave., Cleveland, Ohio.

Coastal Bend Chapter—Southwestern Region
Chairman—L. H. KINDEL, Central Power & Light Co., 120 N. Chaparral, Corpus Christi, Texas.
Secretary — A. D. WILLIAMS, General Electric Co., 1630 S. Brownlee, Corpus Christi, Texas.

Coastal Empire Chapter—Southeastern Region
Chairman — LLOYD L. BLACK, Graybar Electric Co., Inc., 2601 Whitaker St., Savannah, Ga.
Secretary — LEON R. CASE, JR., Savannah Electric & Power Co., P. O. Box 949, Savannah, Ga.

Connecticut Section—Northeastern Region
Chairman — W. P. CARPENTER, The Superior Electric Co., 83 Laurel St., Bristol, Conn.
Secretary — ROBERT H. CHASE, Hartford Electric Light Co., 266 Pearl St., Hartford, Conn.

Cornhusker Section—Midwestern Region
Chairman — H. J. PALMER, JR., 305 36th St., Sioux City, Ia.
Secretary — ROBERT W. BREWER, Iowa Public Service Co., Box 778, Sioux City, Ia.

East Bay Section—South Pacific Coast Region
Chairman—G. N. RADFORD, Pacific Gas & Electric Co., 1625 Clay St., Oakland, Calif.
Secretary—WALKER BROWN, Weld-Rite Co., 4417 Oakport St., Oakland, Calif.

Eastern New York Section—Northeastern Region
Chairman — JOHN M. HARNEY, Smith Electric Co., Inc., 110 Remsen St., Cohoes, N. Y.
Secretary — CHARLES E. WALDRON, 45 Adams Place, Delmar, N. Y.

Eastern Pennsylvania Section—East Central Region
Chairman—TO BE ANNOUNCED.
Secretary — R. C. HAMMER, Pennsylvania Power & Light Co., 9th & Hamilton Sts., Allentown, Pa.

Edmonton Section—Pacific Northwest Region
Chairman — D. A. TUCKER, Western Electrical Constructors, 316 Northern Hardware Bldg., Edmonton, Alta.
Secretary — H. E. MATHER, Alberta Electrical Supplies, Ltd., 10168 106th St., Edmonton, Alta.

Florida Section—Southeastern Region
Chairman—K. D. BRUMBAUGH, 1635 Stanford Lane, Sarasota Fla.
Secretary — SEYMOUR BELL, Sarasota Electric Corp., 1021 Central Ave., Sarasota, Fla.

Forest City (London) Chapter—Canadian Region
Chairman — W. DODD, 1528 Fremont Drive, S. S. 3, London, Ont.
Secretary — G. L. THEAKSTON, 327 Ridgewood Cres., Kensal Park, P. O., Ont.

(*Continued on page* 20A)

(*Continued from page* 19A)

Georgia Section—Southeastern Region
Chairman — SAYLORS J. ANDRE, Georgia Power Co., 15 Forsyth St., Atlanta, Ga.
Secretary—TO BE ANNOUNCED.

Golden Gate Section—South Pacific Coast Region
Chairman—WALTER G. BAYHA, Weir & Finato, 1045 Sansome St., San Francisco, Calif.
Secretary — ARTHUR S. TYLOR, 1037 Cortez Ave., Burlingame, Calif.

Golden West Chapter—Pacific Northwest Region
Chairman — L. H. RITENBERG, 3617 Mason Ave., Regina, Sask.
Secretary — W. J. HEMS, Canadian General Electric Co., 105 Brent Bldg., Regina, Sask.

Heart of America Section—Midwestern Region
Chairman — ROBERT W. WILSON, Boese Hilburn Electric Co., 123 W. 8th St., Kansas City, Mo.
Secretary—CHARLES J. PURCELL, 615 W. 70th St., Kansas City, Mo.

Indiana Section—Midwestern Region
Chairman — ALFRED S. COFFIN, JR., Public Service Co. of Indiana, Inc., 1000 East Main, Plainfield, Ind.
Secretary — M. B. WOLFE, Public Service Co. of Indiana, Inc., 725 Wabash Ave., Terre Haute, Ind.

Inland Empire Chapter—Pacific Northwest Region
Chairman—HARRY R. LOBDEL, Columbia Electric & Mfg. Co., 2310 N. Fancher Way, Spokane, Wash.
Secretary — RAY D. ROOKEY, Washington Water & Power Co., West 825 Trent, Spokane, Wash.

Iowa Section—Midwestern Region
Chairman— MARY E. STAFFORD, Thomas Electric Co., 816 Locust St., Des Moines, Ia.
Secretary — L. J. KINGSLEY, Crescent Electric Supply Co., 313 S. W. 5th St., Des Moines, Ia.

Maritime Chapter—Canadian Region
Chairman—E. J. WILCOX, 54 Elliott Row, St. John, N. B.
Secretary — RALPH W. MCFARLANE, Electric Service League, 1 Dock St., St. John, N. B.

Maryland Section—East Central Region
Chairman — JAMES D. SMITH, General Electric Co., 1401 Parker Road, Baltimore, Md.
Secretary — SIMON E. EHRLICH, 3508 Marryale Road, Baltimore, Md.

Miami Valley Section—Great Lakes Region
Chairman — GLENN A. GRIER, 8530 Inwood Ave., Dayton, Ohio.
Secretary — STANLEY L. BURNHAM, General Electric Co., 225 N. Wilkenson, Dayton, Ohio.

Michigan Section—Great Lakes Region
Chairman — EDMUND W. PRATT, Detroit Edison Co., 2000 2nd Ave., Detroit, Mich.
Secretary — WALTER A. HEDRICH, University of Michigan, Ann Arbor, Mich.

Mid-South Chapter—South Central Region
Chairman—M. E. BROOM, Southern College of Optometry, 1246 Union Ave., Memphis, Tenn.
Secretary — GEORGE R. PATTERSON, 4776 Welchshire Ave., Memphis, Tenn.

Milwaukee Section—Midwestern Region
Chairman — ROBERT J. PRESENT, 743 N. 4th St., Milwaukee, Wis.
Secretary — CLARENCE A. KNOERR, Knoerr & Fischer, Inc., 1015 N. Milwaukee St., Milwaukee, Wis.

Mississippi Chapter—South Central Region
Chairman—C. E. STRAHAN, JR., 1038 Voorhees St., Jackson, Miss.
Secretary — STEPHEN H. TURNER, Mississippi Power & Light Co., 144 South Congress, Jackson, Miss.

Montreal Section—Canadian Region
Chairman — JOHN E. SHEPHERD, 555 40th Ave., La Salle, Que.
Secretary—W. G. MOORE, Electrolier Mfg. Co., Ltd., 5849 Boyer St., Montreal, Que.

Mother Lode Chapter—South Pacific Coast Region
Chairman — EARL E. STORES, Industrial Electrical Consultant, P. O. Box 167, Stockton, Calif.
Secretary — JOHN C. ZEHMS, Pacific Gas & Electric Co., 1050 High St., Auburn, Calif.

New England Section—Northeastern Region
Chairman — RICHARD E. SMITH, 68 Bridge St., Manchester, Mass.
Secretary—PAUL M. CROSBY, Cambridge Electric Light Co., 46 Blackstone, Cambridge, Mass.

New Jersey Section—Northeastern Region
Chairman — JOHN F. MACDOUGALL, 25 Hillcrest, Madison, N. J.
Secretary — J. I. HARGIS, Day-Brite Lighting, Inc., P. O. Box 349, Bloomfield, N. J.

New Mexico Chapter—Inter-Mountain Region
Chairman — OLEN PEDDY, Public Service Co. of N. M., P. O. Box 1360, Albuquerque, N. M.
Secretary — JAMES J. HALLEK, 4204 Palo Duko, N. E., Albuquerque, N. M.

New Orleans Section—South Central Region
Chairman — GEORGE J. SEGAL, New Orleans Public Service, Inc., 317 Baronne St., New Orleans, La.
Secretary — JAMES A. STELLY, Gulf States Utilities Co., 446 North Blvd., Baton Rouge, La.

New York Section—Northeastern Region
Chairman — WILLIAM H. KEEN, General Electric Co., 570 Lexington Ave., New York, N. Y.
Secretary — ROLLO G. WILLIAMS, Century Lighting, Inc., 521 W. 43rd St., New York, N. Y.

North Texas Section—Southwestern Region
Chairman—PAUL A. CRICK, Trade Mart, Rm. 2000, 2100 Stemmons Expressway, Dallas 7, Texas.
Secretary—WILLIAM T. KIMERY, Dallas Power & Light Co., 1506 Commerce, Dallas, Texas.

Northwestern Ohio Section—Great Lakes Region
Chairman — H. W. TEELE, JR., Toledo Edison Co., Edison Bldg., Toledo, Ohio.
Secretary — AUDREY C. WEGENER, 3625 Sherbrooke Road, Toledo, Ohio.

Ohio Valley Section—Great Lakes Region
Chairman — FRED B. MACRAE, Edwin F. Guth Co., 6503 Tyne Ave., Cincinnati, Ohio.
Secretary—HAROLD J. GRUBER, Cincinnati Gas & Electric Co., 4th & Main Sts., Cincinnati 2, Ohio.

Oil Capital Section—Southwestern Region
Chairman — RICHARD ALMOND, Almond Electric Co., 1005 E. 4th, Tulsa, Okla.
Secretary — JOHN C. PENAFEATHER, Leon B. Senter, Architect, 307 Philtower Bldg., Tulsa, Okla.

Oregon Section—Pacific Northwest Region
Chairman—JOHN A. SCHULTER, 411 Weatherly Bldg., Portland, Ore.
Secretary — W. GLENN PRACEJUS, General Electric Co., 2800 N. W. Nela, Portland, Ore.

Ottawa Section—Canadian Region
Chairman — ANDREW D. MILLER, 1122 Bedbrooke St., Ottawa, Ont.
Secretary—W. H. JOHNSTON, 1605 Alta Vista Drive, Ottawa, Ont.

Ozark Chapter—Midwestern Region
Chairman — HAROLD STAHL, Lamons Electric Co., 1950 S. Glenstone, Springfield, Mo.
Secretary — C. G. WELLS, 1855 Valley Road, Springfield, Mo.

Palmetto Section—Southeastern Region
Chairman—R. L. ADAMS, South Carolina Electric & Gas Co., 1309 Hampton St., Columbia, S. C.
Secretary — MIREILLE W. THOMPSON, Laurel Hill Rt. 4, Brevard Road Box 61, Hendersonville, N. C.

Panhandle Chapter—Southwestern Region
Chairman — GORDON BALDRY, 2117 Tyler, Amarillo, Texas.
Secretary — OTHO W. WALKER, Nunn Electric Supply Corp., 105 Polk, Amarillo, Texas.

Philadelphia Section—East Central Region
Chairman—WILLIAM P. GRAHAM, Philadelphia Electric Co., 211 S. Broad St., Philadelphia, Pa.
Secretary—STANLEY W. PURDUM, Philadelphia Electric Co., 211 S. Broad St., Philadelphia, Pa.

Pittsburgh Section—East Central Region
Chairman — DONALD C. THOMAS, 124 Barbour Drive, Pittsburgh, Pa.
Secretary — HENRY J. MAZUR, Westinghouse Electric Corp., 306 4th Ave., Pittsburgh, Pa.

Puget Sound Section—Pacific Northwest Region
Chairman — JACK H. WELLS, 3405 Kromer Ave., Everett, Wash.
Secretary — JAMES A. FREDRICKSON, General Electric Co., 10 W. Connecticut, Seattle, Wash.

Rochester Section—Great Lakes Region
Chairman — HERBERT S. GLICK, Eastman Kodak Co., Kodak Park, Rochester, N. Y.
Secretary — GEORGE R. BUTLER, 7 Maple St., Pittsford, N. Y.

Rocky Mountain Section—Inter-Mountain Region
Chairman — GALE H. PATTERSON, General Electric Supply Co., 1429 18th St., Denver, Colo.
Secretary—FRED H. ROSENQUIST, Public Service Co. of Colorado, 900-910 15th St., Denver, Colo.

St. Louis Section—Midwestern Region
Chairman—WILLIS MANGOLD, General Electric Co., 710 N. 12th St., St. Louis, Mo.
Secretary—NORMAN L. KRAUSE, Sach's Electric Co., 5540 W. Park, St. Louis, Mo.

St. Maurice Valley Chapter—Canadian Region
Chairman—JEAN PAUL MORIN, Canadian Westinghouse Co., Ltd., 415 Craig St. W., Montreal, Que.
Secretary — GASTON J. LABROSSE, Northern Electric Co., Ltd., 2620 Notre Dame, Trois Rivieres, Que.

San Diego Section—South Pacific Coast Region
Chairman—EDWARD L. PETERSON, Edward L. Peterson Co., 709 Bank of America Bldg., San Diego, Calif.
Secretary — ALAN J. MCCUTCHEON, JR., San Diego Gas & Electric Co., 861 6th Ave., San Diego, Calif.

San Jacinto Section—Southwestern Region
Chairman—RICHARD C. JUNG, General Electric Co., 4219 Richmond Ave., Houston, Texas.
Secretary—ROBERT PUTTERMAN, R. A. Putterman Co., 4101 San Jacinto, Houston, Texas.

San Jose Chapter—South Pacific Coast Region
Chairman—GEORGE SMEDBERG, Westlite, P. O. Box 1033, Redwood City, Calif.
Secretary—DALE R. JENSEN, International Business Machines, Monterey & Cottle Rd., San Jose, Calif.

Southeast Florida Section—Southeastern Region
Chairman—FRANK E. YANAROS, Florida Power & Light Co., P. O. Box 1057, Hialeah, Fla.
Secretary—BESS JONES, 95 N. E. 71st St., Miami, Fla.

Southern California Section—South Pacific Coast Region
Chairman—BENN J. HARTMANN, Flood-Lite Service, 212 Silverlake Blvd., Los Angeles, Calif.

(*Continued on page* 34A)

Gotham Lighting Corporation announces a new group of recessed fresnelens downlites with wide-angle distribution[1] to meet the needs of architects, designers and engineers. These units combine optically engineered Alzak reflectors with exclusive Gotham fresnelenses[2] to produce high efficiency[3] and comfortable brightness. Twist-lock fastened[4] hinged doors are featured in all units, adding to the clean appearance by eliminating visible hardware. Two series of downlites comprise the groups: Series 5000[5] which have lenses set flush with the ceiling, and Series 5100[5] with lenses regressed above the ceiling plane.

Cross-section of typical 5100 Series unit

1
For uniform illumination, these downlites can be installed so that the space between units is the same as the height of the ceiling above the work plane.

2
Extensive optical research led to a development of exclusive lenses based on a new concept in prism contour and rear surface pattern. These lenses, coupled with mathematically derived Alzak reflectors, produce a significant advancement in performance over conventional fresnelens units.

3
Efficiencies for the 5000 series range from 61.5% to 71.5%, and from 56.5% to 68.5% for the 5100 series (by E. T. L. test).

4
The twist-lock fastened door can be opened by hand or by pole from the floor for relamping and maintenance.

5
For complete data, write:

GOTHAM LIGHTING CORPORATION
37-01 Thirty-first Street
Long Island City 1, N. Y.

LPI LIGHTING REPORT

How to choose the right diffuser for fluorescent lighting applications

Published as a service to the lighting industry
by Lighting Products Inc., Highland Park, Illinois

Fluorescent lighting diffusers should be designed to achieve proper brightness balance and even light distribution. They shield light, transmit it, redirect or diffuse it. They do this by means of metal or plastic "egg crates," baffle systems, or complex configurations of plastic and glass. Some diffusers serve the added function of preventing dust or moisture from entering the luminaire.

Selection of the right diffuser for an application is based on the illumination control that is required as well as economic and esthetic considerations. The table below is designed to aid in making a choice among ten typical diffusers on the basis of their relative costs and of their brightness control at six angles of vision as well as control of brightness on the visual task itself.

The relative costs of diffusers listed in the table are represented by index figures. In calculating the cost index of any diffuser, maintenance is an important consideration. The diffuser should be easy to clean and durable enough to withstand normal cleaning and maintenance over a period of many years. These factors are reflected in the figures given. The acrylic formed diffuser is used as a base at 100. Comparative cost indexes for other types of diffusers follow in decreasing order. The vinyl pan is rated at 20 and costs only one-fifth as much as acrylic formed diffuser.

DIFFUSER SELECTION TABLE

Type of Diffuser	Relative Cost Index	Maximum brightness in footlamberts at indicated viewing angles for both crosswise and lengthwise shielding — measured on typical 2x4 troffer with four 40w rapid start lamps.											
		Nadir		45°		55°		65°		75°		85°	
		Cross-wise	Length-wise	Cross-wise	Length-wise	Cross-wise	Length-wise	Cross-wise	Length-wise	Cross-wise	Length-wise	Cross-wise	Length-wise
Acrylic Formed Diffuser	100	750	760	680	680	650	640	625	600	550	540	440	425
Hex Aluminum Louver	80	Lamp Brightness		640	640	450	400	325	350	225	250	140	185
Fiberglass Flat Sheet	80	1150	1000	860	780	700	600	550	500	450	450	380	400
Vinyl Circular Louver Grid, White	32	Lamp Brightness		800	700	650	500	450	400	380	350	300	275
Vinyl Circular Louver Grid, Gray	32	Lamp Brightness		800	700	600	550	425	400	275	250	180	150
Pigmented Ventrolens Diffuser	32	850	860	700	650	590	550	490	480	450	450	375	400
Gray ½"-Cell Plastic Louver	32	Lamp Brightness		650	725	500	475	400	375	320	300	225	250
Clear Prismatic Ventrolens Diffuser	30	1650	1650	1020	800	650	500	480	400	375	325	260	180
White ½"-Cell Plastic Louver	30	Lamp Brightness		650	680	500	650	450	625	380	550	350	325
Formed Vinyl Pan	20	750	750	750	740	725	700	650	625	600	600	600	575

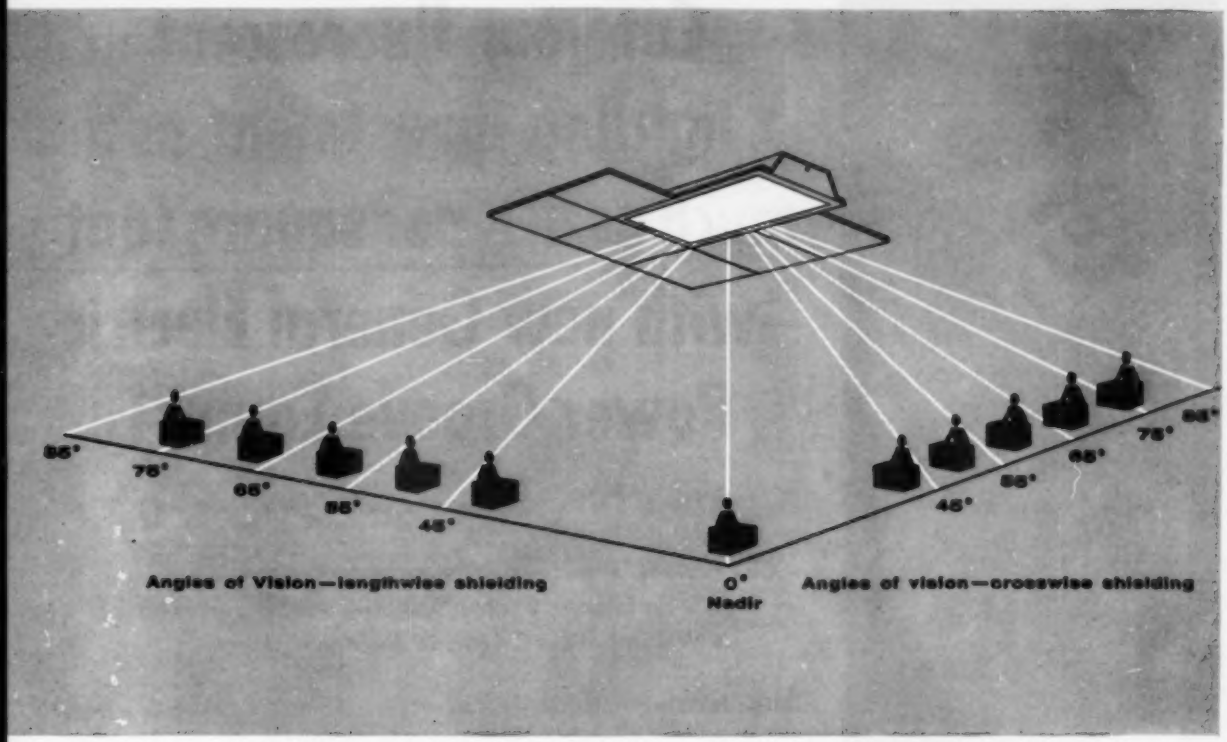


Illustration shows viewing angles at which brightness values were measured for ten types of diffusers. Results for both crosswise and lengthwise shielding are shown on Diffuser Selection Table.

Once the desired lighting level and the type of fixture required for an installation are determined, a diffuser with the proper characteristics for the application should be selected. The table will aid in determining which diffuser best meets brightness requirements. It shows brightness in footlamberts for the ten types of diffusers and at six angles of view — both lengthwise and crosswise as illustrated in the diagram above.

These angles of view are significant in relation to the size of the room. For a large room, it is important to consider brightness at low angles because raising the line of sight 10 to 15 degrees may bring the luminous section of the diffuser into sight. In small rooms, viewing angles in the 45 to 65 degree zone may be of greater importance.

Brightness at nadir is a meaningful factor when considering glare. If reflectance of a lamp from a work surface is objectionable, a diffuser which shields lamp brightness in this zone should be selected. Louver systems or grid type diffusers are less satisfactory than closed type diffusers for shielding the brightness of the fluorescent lamp at nadir.

Note that pigmented-louver diffusers have significantly lower brightness at lower angles. For example, the vinyl circular louver grid in white is rated at 300 footlamberts at a viewing angle of 85°; the same diffuser in gray reduces brightness to 180 footlamberts. At nadir, both diffusers permit lamp brightness. The brightness of pigmented ventrolens at nadir is 850 footlamberts; at an angle of 85°, brightness is 375.

Diffusers have an important effect on the efficiency of the luminaire. A typical troffer has 67% efficiency using clear ventrolens diffuser. If the diffuser is pigmented to provide better control over direct glare, efficiency is reduced to 60%. Vinyl pan further reduces luminaire efficiency to 54%.

The table enables comparisons of performance and economic factors for the ten diffusers shown. Selecting a diffuser on the basis of this data makes it simpler to achieve a proper balance of lighting efficiency, pleasing appearance, and cost.

Reprints available—If you would like reprints of this discussion for your own use or for others in your organization, we will be pleased to provide them. Drop us a line mentioning the number of Diffuser Selection Reprints you would like. Also, please remember that your LPI representative is always ready to offer technical assistance on every aspect of fluorescent lighting.

Lighting Products Inc., Highland Park, Illinois

LPI FLUORESCENT LIGHTING

Cut your fluorescent lighting investment as much as 40¢ per square foot —with new General Electric Power Groove Lamps!

- Power Groove gives lowest cost of fluorescent light for most users...
- Saves 10-30% on initial investment, alone...
- Stays cleaner, brighter longer—cuts end darkening
- Will last about 3 years in single-shift service

INITIAL INVESTMENT REDUCED—*You can save up to $4,000 on every 10,000 square feet of lighted floor area* by specifying new General Electric Power Grooves over other types of fluorescent lamps. This is based on a typical industrial area and a practical 100 footcandle lighting level which will help you get increased production through higher worker efficiency and comfort.

HOW? Use new G-E Power Grooves, the most powerful fluorescent you can buy. If you're in the midst of planning a new building, or remodeling an existing one, you'll welcome the sizeable savings in capital investment. For a given lighting level, you need fewer G-E Power Groove Lamps, fewer fixtures . . . less installation time.

COMPARE POWER GROOVE COSTS: Using average conditions, figuring the cost of the lamps, fixtures, distribution equipment and labor, here's a cost comparison of the major types of fluorescents:

YOU CAN SAVE THIS MUCH ON INITIAL INVESTMENT BY USING 8-FOOT G-E POWER GROOVE LAMPS

(Based on a desirable 100 footcandle level, at about 95¢ per square foot using Power Grooves)

	YOUR SAVINGS PER FOOT	YOUR SAVINGS PER 10,000 FT.
POWER GROOVES vs. 4′ 40-WATT RAPID START (at $1.35/sq. ft.)	40¢	$4,000
POWER GROOVES vs. 8′ SLIMLINE LAMPS (at $1.35/sq. ft.)	40¢	$4,000
POWER GROOVES vs. 8′ HIGH OUTPUT LAMPS (at $1.15/sq. ft.)	20¢	$2,000

NEW G-E POWER GROOVES come in 4, 6, and 8-foot lengths—and all have the new G-E cathode shield that keeps ends brighter longer. This collects the tiny electrode particles that would otherwise be deposited on the tube wall. These lamps are interchangeable with original Power Grooves—yet they sell for the same price! For more information, write: General Electric Co., Large Lamp Dept. C-920, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

COMMITTEE PERSONNEL

COMMITTEES 1959-1960

All committees are appointed by the President, subject to approval of the Council. Except as provided in the Constitution, appointments terminate at the time of the first Council meeting of the following administration. The scope of each committee is indicated.

J. B. Browder, President, ex-officio member of all Standing, General and Task Committees, except Board of Fellows, Board of Nomination and Medal Award Committee.

R. G. Slauer, Vice-President, ex-officio member of all Technical Committees, (by appointment).

STANDING COMMITTEES

COUNCIL EXECUTIVE—To conduct the affairs of the Society between Council meetings.

J. B. Browder, Chairman, Georgia Power Co., 75 Marietta St., N.W., Atlanta, Ga.

J. R. Chambers	W. P. Lowell, Jr.
G. F. Dean	R. G. Slauer

BOARD OF FELLOWS—To evaluate the eligibility of candidates for transfer to the grade of Fellow, according to procedures approved by Council.

Willard Allphin, Chairman, Sylvania Electric Products, Inc., Salem, Mass.

L. E. Barbrow	Leland H. Brown
J. W. Bateman	Bruce J. Jensen

George P. Wakefield

FINANCE—To have direct supervision of the financial affairs of the Society and to present to the Council an annual report on its financial condition. To make recommendations to the Council as to the investment of moneys and upon all specific appropriations. To prepare and submit for approval of Council not later than the first new Council meeting a budget of income and expense for the ensuing fiscal year.

W. P. Lowell, Jr., Chairman, Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

A. C. Barr	Max D. Orr
H. S. Beagle	C. C. Shotwell

R. M. Zabel

GENERAL BOARD OF EXAMINERS—To investigate the qualifications of all applicants for admission to membership; to elect or reject applicants for the grade of Associate Member and Student Member, to report such action to the Council; and to make recommendations to the Council regarding applications for transfer or election to the grade of Member or Retired Member, and for transfer to the grade of Member Emeritus.

H. E. D'Andrade, Chairman, General Electric Co., 570 Lexington Ave., New York, N. Y.

Svend W. Bruun Taylor Barr

PAPERS—To procure, review and approve all technical papers and discussions thereof, for presentation before National Conferences of the Society.

Floyd W. Sell, Chairman, The Detroit Edison Co., 2000 Second Ave., Detroit, Mich.

B. S. Benson, Vice-Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

F. G. Breckenridge	J. William Griffith
James Cox	J. S. Hamel
C. M. Cutler	Leon T. Johnson
H. F. Davidson	T. C. Sargent
Kurt Franck	G. A. Trosper
O. B. Goldsmith	George Wakefield

R. S. Wiseman

PUBLICATIONS—To be responsible for the procurement, review and approval of all material for the publications of the Society other than technical papers approved by the Papers Committee for presentation at National Conferences of the Society and their discussions and committee reports, for which it will have publication responsibility only. Shall also be responsible for the editing, printing and business management of the publications of the Society; specific exceptions may be made by Council.

R. M. Zabel, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

R. W. Morris, Vice-Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

C. L. Amick	Floyd W. Sell
Brooks Chassaing	Nelson Warner

GENERAL COMMITTEES

ADVANCE PLANNING—To study the long range objectives of the Society—its operation, program, publication activities, membership classifications and financial structure, and to make recommendations to Council.

J. Dixon Mitchell, Chairman, Westinghouse Electric Corp., 2260 Peachtree Industrial Blvd., Chamblee, Ga.

A. C. Barr	John J. Neidhart
C. W. McCormick	L. C. Twichell
W. P. Lowell, Jr.	J. D. Whitnell

ALLIED ARTS—To encourage and assist local competitions in allied arts, in cooperation with technical committees and interested local groups.

J. D. Whitnell, Chairman, Arizona Public Service Co., P.O. Box 2591, Phoenix, Ariz.

Karl A. Staley, Secretary, General Electric Co., Nela Park, Cleveland 12, Ohio

Carl Albach	L. T. Kight
Roy Dahlin	William M.C. Lam
John Felton	John A. Russell

BOARD OF NOMINATION—To prepare a nomination ticket containing the names of those who are deemed best suited to serve as officers and directors in positions to be filled at the ensuing election.

M. N. Waterman, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

K. M. Reid G. J. Taylor

and Regional Representatives

CONSTITUTION AND PROCEDURES—To prepare proposed amendments to the Constitution and By-laws, to prepare statements of policies and procedures consistent with the Constitution and By-laws, and to report to Council.

L. C. Twichell, Chairman, Rochester Gas & Electric Corp., 89 East Ave., Rochester 4, N. Y.

G. F. Dean	C. C. Keller
R. F. Hartenstein	Glenn E. Park

Walter Sturrock

DEFENSE COORDINATING—To contact various government agencies concerned with national security suggesting cooperation and participation in specific projects as an aid to solution of their problems. Recommending the placement of lighting study projects in present committees or the appointment of study project committees to the Society President and to expedite such study projects and guide accepted reports into proper Government channels.

J. W. Bateman, Co-Chairman, Canadian General Electric Co., Ltd., 212 King St. W., Toronto, Ont.

A. F. Wakefield, Co-Chairman, The Wakefield Co, Vermilion, Ohio.

H. R. Blackwell	O. P. Cleaver
R. B. Brown, Jr.	John S. Walsh

HISTORICAL—To assemble and make available for current reference and to prepare in suitable and durable form for posterity, such historical facts, printed memorabilia, photographs, voice records, museum specimens and allied items as may be judged worthy of composing a continuing digest of the record of the Society's history.

H. L. Logan, Chairman, Holophane Co., Inc., 342 Madison Ave., New York 17, N. Y.

W. F. Bear	Leo Dolkart
James Cravath	C. A. B. Halvorson
Julius Daniels	S. G. Hibben

J. L. Stair

MEDAL AWARD—To evaluate the eligibility of candidates for award of the I.E.S. Medal according to procedures approved by the Council.

J. F. Whitehead, Jr. Chairman, Day-Brite Lighting, Inc., 5411 Bulwer Ave., St. Louis 7, Mo.

Milton B. Hastings	Edward Rambusch
W. F. Little	G. J. Taylor
H. H. Magdsick	A. F. Wakefield
Kirk M. Reid	M. N. Waterman

MEMBERSHIP—To develop plans and supervise the operation of the individual membership activity of the Society.

J. C. Forbes, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

A. C. Brodeur H. J. Poehling

R. M. Taylor

and Regional Representatives

NATIONAL TECHNICAL CONFERENCE—To be completely responsible, subject to the approval of Council, for the general coordination of all conference activities, for selecting and recommending time and place, for review of the plans and budgets of the National Technical Conference Executive Committee, and in cooperation with the Papers Committee for the satisfactory time allocation for the Technical Papers sessions, according to Procedures and Policies as adopted by Council.

C. L. Amick, Chairman, Day-Brite Lighting, Inc., 5411 Bulwer Ave., St. Louis, Mo.

J. Carl Wilson, Vice-Chairman, J. A. Wilson Lighting & Display, Ltd., 280 Lakeshore Rd., Toronto, Ont.

J. W. Bateman	C. W. McCormick
R. W. Brown	C. D. Miller
Brooks Chassaing	J. D. Mitchell
John B. Deck, Jr.	P. M. Rutherford
R. T. Dorsey	Floyd W. Sell
C. N. Laupp	John S. Walsh
W. P. Lowell, Jr.	N. C. Warner

1960 Conference Executive Committee

Nelson Warner, Chairman, Westinghouse Electric Corp., 306 Fourth Ave., Pittsburgh, Pa.

(*Continued on page* 26A)

(*Continued from page 25A*)

PUBLIC RELATIONS AND INFORMATION—To prepare and disseminate information about the activities, accomplishments, programs, objectives and policies of the Society and about the place of illuminating engineering in modern society; to formulate and submit public relations policies and plans to the Society.

W. A Dalrymple, Chairman, Amalgamated Electric Corp., Ltd., 384 Pape Ave., Toronto, Ont.

ft. E. Ballard, Vice-Chairman, Connecticut Power & Light Co., P.O. Box 2010, Hartford, Conn.

John F. Eichorn — R. W. Sclater
John Ronayne — L. E. Tayler
Gordon Wells

REGIONAL ACTIVITIES—To represent the respective Regions before the Council and to keep the Council informed regarding the affairs of the Regions. To stimulate Society activities, to encourage joint meetings of Sections and Chapters including Regional Conferences within the respective Regions, and to promote the expansion of the Society.

J. R. Chambers, Chairman, Appleton Electric Co., 1701-1759 Wellington Ave., Chicago, Ill.

J. E. Barnes — J. B. Deck, Jr.
R. W. Brown — J. M. Gensburger
Cecil L. Cannon — C. D. Miller
Brooks Chassaing — L. S. Reed
J. M. Chorlton — R. L. Smart
B. A. Travis

RESIDENCE LIGHTING FORUMS—To stimulate and assist the Residence Lighting Forums of the Society and to encourage the formation of additional forums. To conduct a Residence Lighting Forum in connection with the National Technical Conference.

Eve Freyer, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

Katherine Goodall — Aileen Page
Ben Goodman — R. M. Taylor
Virginia Skinner
and Chairmen of the local Forums

SUSTAINING MEMBERSHIP—To develop plans and supervise the operation of the Sustaining Membership activity in the Society according to the Procedures and Policies adopted by Council.

G. J. Taylor, Chairman, Day-Brite Lighting, Inc., 122 E. 42nd St., New York, N. Y.

B. F. Benning — E. C. Huerkamp
Warren W. Booth — J. J. McLaughlin
Eric H. Church — C. C. Shotwell
L. E. Tayler

TRUSTEES, I.E.S. HEADQUARTERS RETIREMENT PENSION PLAN

K. M. Reid, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio

W. P. Lowell, Jr. — G. J. Taylor

TASK COMMITTEE

RESEARCH FINANCING—To determine how the long range financial needs of the Illuminating Engineering Research Institute research program may be met.

Kirk M. Reid, Chairman, General Electric Co., Nela Park, Cleveland, Ohio.

C. C. Shotwell — A. F. Wakefield
R. G. Slauer — M. N. Waterman
E. M. Strong — J. F. Whitehead, Jr.

TECHNICAL COMMITTEES

AVIATION AND SIGNAL—To study the application of light and lighting to the spaces and functions involved in the operation of aircraft.

M. A. Warskow,* Chairman, Airborne Instrument Laboratories, Inc., Melville, Labs., Walt Whitman Rd., Melville N. Y.

F. C. Breckenridge,* Technical Secretary, National Bureau of Standards, Washington 25, D. C.

Aircraft Lighting

Warren Hulke,* Chairman, Solerberg Manufacturing Co., 628 S. Palm Ave., Alhambra, Calif.

W. E. Woodson, Secretary, Convair Corp., Division of General Dynamics, P. O. Box 1950, San Diego, Calif.

W. C. Fisher, Papers Coordinator, Bureau of Aeronautics, Dept. of Navy, Washington 25, D. C.

F. C. Ashe — J. Gordon Hoffman
E. Boghosian — W. D. Howell
F. B. Brady — J. P. Hoxie
F. C. Breckenridge — W. A. Jensen
D. I. Coggins — D. C. Miller
H. A. Cramer — M. A. Mortensen
R. K. Davis — T. H. Projector
C. A. Douglas — Norbert Schwenkler
I. Fagin — F. C. Shipley
S. R. Goldfarb — R. J Stefany
P. H. Greenlee — R. A. Stone
G. K. C. Hardesty — M. A. Warskow

BIBLIOGRAPHY

Frank Ashe, Chairman, Kopp Glass Inc., Swissvale, Pittsburgh 18, Pa.

COCKPIT LIGHTING

Dean Pierce, Chairman, Lockheed Aircraft Corp., Burbank, Calif.

Al Bennett — J. Ransford
Charles Touhy

EXTERIOR LIGHTING

Mel Clayton, Chairman

Paul Greenlee — Jack Shearer
E. A. Jensen — Wm. Struklj

INTERIOR LIGHTING

Wesley Woodson, Chairman, Convair Division of General Dynamics Corp., P. O. Box 1950, San Diego 12, Calif.

R. K. Davis — Carl F. Jensen
W. Fisher — A. L. McIntyre
Edwin Ford — C. S. Millikan
Robert Hadzor — J. W. Tuttle
C. T. White

LAMPS (SMALL)

M. A. Mortensen, General Electric Co., Nela Park, Cleveland 12, Ohio.

E. Bosworth — W. T. Harding
C. Christenson — W. Lawton
W. Fisher — R. Stone
H. R. Van Saun

Ground Lighting

R. J. Stefany,* Chairman, Westinghouse Electric Corp., 1625 K St., N.W., Washington 6, D. C.

J. P. Hoxie, Secretary, Corning Glass Works, Corning, N. Y.

C. A. Douglas, Papers Coordinator, National Bureau of Standards, Washington 25, D. C.

J. F. Angier — L. W. Hornfeck
F. C. Ashe — Warren Hulke
E. Boghosian — W. A. Jensen
F. B. Brady — G. F. Johnston
F. C. Breckenridge — C. E. Leberknight
W. D. Callaghan — C. J. McDonald
F. E. Carlson — W. A. Pennow
P. B. Clark — F. C. Shipley
G. K. Clement — L. C. Simpson
D. I. Coggins — R. A. Stone
V. E. Converso — L. C. Vipond
E. A. Cuttrell — A. E. Wallis
O. F. Farris — M. A. Warskow
D. M. Finch — H. A. Williams
J. S. Haney — J. P. Wilson
R. D. Harts — A. B. Winters

*Members of Executive Committee.

APPROACH LIGHTING

D. I. Coggins, Chairman, Sylvania Electric Products Inc., Photoflash Division, 60 Boston St., Salem, Mass.

E. A. Cuttrell — O. F. Farris
C. A. Douglas — G. M. Kevern

AVIATION LAMPS (LARGE)

F. E. Carlson, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

BIBLIOGRAPHY

F. C. Ashe, Chairman, Kopp Glass Inc., Palmer St., Swissvale, Pittsburgh 18, Pa.

T. M. Edwards — J. P. Hoxie

HELIPORT LIGHTING

V. E. Converso, Chairman, Port of New York Authority, 111 Eighth Ave., New York, N. Y.

J. S. Haney — H. Higgins
R. D. Harts — E. G. Rudberg
L. C. Vipond

RUNWAY LIGHTING

A. E. Wallis, Chairman, Wright Air Development Center, Wright Patterson Air Force Base, Dayton, Ohio.

L. Achitoff — R. C. Herner
G. K. Clement — W. A. Jensen
C. A. Douglas — C. J. McDonald
L. C. Vipond

SEADROME LIGHTING

R. D. Harts, Chairman, Bureau of Aeronautics, Navy Department, Washington, D. C.
R. C. Preston — G. A. Rodney
J. E. Wesler

SERVICE AREA LIGHTING

E. B. Karns, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio.

R. H. Goodman — G. F. Johnston
W. A. Jensen — H. A. VanDusen, Jr.
H. W. Wenson

TAXIWAY LIGHTING

H. B. Decker, Chairman, Federal Aviation Agency, Columbian Bldg., 416 - 5th St. N. W., Washington, D. C.

G. K. Clement — R. L. Paugh
V. E. Converso — R. Pierce
J. F. Davis — E. G. Rudberg
J. D. McKinney — H. A. Williams

Signal Lighting

J. F. Angier,* Chairman, 14 Valley View Ave., Washington 12, D. C.

T. G. Andrews — F. C. Breckenridge
H. R. Blackwell — C. A. Douglas
W. E. K. Middleton

COLOR—To study, evaluate and report on the effect of color in relation to the art and science of illumination.

R. C. Allison, Chairman, Engineering and Design Dept., The T. Eaton Co., Ltd., 190 Yonge St., Toronto 1, Ont.

W. E. Carswell — G. F. Dean

DAYLIGHTING — To study the problems involved in daylighting, develop recommended practices and report thereon.

J. W. Griffith, Chairman, Southern Methodist University, Industrial Engineering Dept., Dallas, Texas.

W. J. Arner — H. F. Kingsbury
R. L. Biesele, Jr. — E. M. Linforth
R. A. Boyd — R. W. McKinley
A. A. Brainerd — F. W. Mowrey
H. S. Bull — Philip O'Brien
T. Carson — R. H. Reed
Benj. H. Evans — F. K. Sampson
W. B. Ewing — Paul W. Seagers
C. D. Gibson — D. E. Spencer
B. F. Greene — K. C. Welch
J. J. Kemendo — O. F. Wenzler**
R. C. Kendall — C. J. Youngblood

**Alternate for W. J. Arner.

Revision of Recommended Practice for Daylighting

R. W. McKinley, Chairman, Pittsburgh Plate Glass Co., 1 Gateway Center, Pittsburgh 22, Pa.

(*Continued on page 28A*)

The right Light Transmission... Color... Shape... and Toughness...
with custom-made Lighting Glassware, Lenses and Color Filters...
engineered by **KOPP**

"One Gob at a time..."

But when that "Gob" has been properly pressed, hardened, annealed and inspected—the finished lens is the product of a complete engineering service.

This service includes developing the right formula of ingredients, engineering the molds, and establishing rigidly-controlled manufacturing procedures. The result is the right combination of properties to provide maximum output of your light source, accurate color transmission, and proper physical characteristics to meet your specific application needs.

TYPICAL PRODUCTS **Cover Glasses (enclosed floodlights, PAR lampholders)**
Lighting Glassware (dental, surgical) • Color Filters (theatre, show windows) • Color Effects (outdoor)
Signal Lenses (traffic, railroad, marine) • Aviation Lighting Glassware (airport and aircraft)
Ultraviolet and Infrared Glass

KOPP GLASS

Ask for Bulletin 553-A on Kopp Engineered Glass

Kopp Glass, INC.

Swissvale, Pennsylvania

(*Continued from page 26A*)

W. J. Arner — R. C. Kendall
E. W. Conover — H. F. Kingsbury
W. B. Ewing — E. M. Linforth
B. F. Greene — T. H. MacDonald
R. M. Hanes — F. W. Mowrey
J. S. Herbert — C. J. Youngblood

DESIGN PRACTICE — To study published data on coefficients of utilization, room indexes, maintenance coefficients and other elements entering into calculations for lighting design; develop standard methods for use in Society publications and report thereon.

R. S. Wiseman, Chairman, Research & Photometric Section, U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va.

G. W. Clark — Phelps Meaker
Ward Harrison — J. J. Neidhart
Harry W. Horn — H. A. Odle
E. H. Salter

EDUCATION — To study and encourage lighting education and training for professional careers in schools, colleges and elsewhere; to prepare educational and training material on fundamental and advanced concepts of light and illumination, and to further its adoption in courses conducted by Sections and Chapters.

Alston Rodgers, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

O. P. Cleaver — H. W. Horn
E. L. Fairchild — Roy A. Palmer
D. M. Finch — R. C. Putnam
W. A. Hedrich — T. H. Shepherd
P. H. Hildebrand — R. S. Wiseman
I. A. Yost

Revision of I.E.S. Courses

C. W. Zersen, Coordinator, Chicago Lighting Institute, 140 S. Dearborn St., Chicago, Ill.

Preparation of Brochure on "Opportunities in Illuminating Engineering"

J. L. Tugman, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

Revision of "Lighting Fundamentals" Course

R. E. Wozniak, Chairman, Chicago Lighting Institute, 140 S. Dearborn St., Chicago, Ill.

Robert Allen — B. F. Avery
A. M. Bacalar

Revision of "Advanced Lighting Design Problems Course"

R. R. Lusk, Chairman, Commonwealth Edison Co., 7601 S. Lawndale Ave., Chicago 29, Ill.

Gerald Marks — J. F. Parsons
William Weibel

HANDBOOK—To have continuous responsibility for appraising the service rendered by the Handbook, for its accuracy and improvement; to advise Council when revisions and new editions are needed. To revise and arrange the technical content of the Handbook; to lay out, plan, and arrange for development of individual sections primarily through appropriate technical committees, to consult with the Publications Committee on its presentation of a suitable publication budget for Council approval; to be responsible to Council for the format, accuracy, and treatment of material.

M. N. Waterman, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

B. J. Jensen — J. J. Neidhart

INDUSTRIAL — To initiate, follow up and coordinate lighting study projects in the industrial field, review the reports of the various subcommittees in this field and make recommendations to Council.

L. G. Parks, Chairman, Ebasco Services, Inc., 2 Rector St., New York, N. Y.

A. A. Brainerd — W. H. Kahler
M. M. Buzan — Norman T. Kridel
H. A. Cook — E. A. Linsday
R. E. Hars — Howard Long
D. J. O'Neill

Aircraft Manufacturing

J. G. Felton, Jr., Chairman, Sylvania Electric Products, Inc., 100 Fordyce St., Dallas, Texas.

Robert S. Clubley

Clothing

Norman T. Kridel, Chairman, Rochester Gas & Electric Co., 89 East Ave., Rochester, N. Y.

Electronics Industry

R. S. Clubley, Chairman, General Electric Co., Large Lamp Dept., 2747 South Malt Ave., Los Angeles 22, Calif.

Graphic Arts

Ralph Enghouser, Chairman, Sylvania Electric Products Inc., 4700 Parkside Ave., Philadelphia, Pa.

Outdoor Production Areas

H. A. Cook, Chairman, Detroit Edison Co., 2000 Second Ave., Detroit 26, Mich.

Donald R. Brown — D. J. O'Neill
William Coffey — W. R. Preece, Jr.
R. E. Faucett — G. L. Sealy
E. I. Feak — Fred Snider
Theodore Summers

Recommended Practice

D. J. O'Neill, Chairman, Holophane Co., Inc., 342 Madison Ave., New York, N. Y.

Theodore Ake — Paul E. King
M. B. Bunson — E. A. Linsday
H. F. Carroll — A. J. McConnell
W. H. Kahler — W. S. Till
H. W. Wenson

Sawmills

James Barnes, Chairman, Pacific Gas & Electric Co., P. O. Box 540, San Rafael, Calif.

INSTITUTIONS — To initiate, follow up and coordinate lighting study projects in the field of public buildings and private institutions, review the reports of the various study subcommittees in this field and make recommendations to Council.

R. D. Bradley, Chairman, Day-Brite Lighting, Inc., 5411 Bulwer Ave., St. Louis, Mo.

B. F. Avery — C. N. Laupp
J. H. McCulloch

Churches

George Shoemaker, Chairman, Philadelphia Electric Co., 211 S. Broad St., Philadelphia 5, Pa.

John Adams — T. Norman Mansell
Anthony L. Bleecker — A. C. Sangster
Henrik W. Olsen

Dining Areas

George Gilleard, Chairman, Curtis Lighting Inc., 6135 W. 65th St., Chicago 38, Ill.

Hospitals

N. L. Griffin, Chairman, Dept. of Health, Education & Welfare, Public Health Service, Div. of Hospital & Medical Facilities, Washington 25, D. C.

H. W. Alexander — H. L. Logan
L. J. Buttolph — R. C. Putnam
E. H. Greppin — Paul Seagers

JOINT FARM (IES-American Society of Agricultural Engineers)—To study the application of light and lighting of farm buildings, surrounding work areas and other rural locations and to report thereon.

Morris Lloyd, Chairman, Niagara Mohawk Power Corp., Buffalo 3, N. Y.

Ervin Baker — **J. P. Schaenzer**
J. P. Ditchman — **M. O. Withed**
D. E. Wiant

JOINT LIGHTING AND AIR CONDITIONING (IES-American Society of Heating, Refrigerating and Air Conditioning Engineers)—To study the relationship between lighting and various factors that enter into the thermal environment and report thereon.

JOINT LIGHTING SURVEY (IES-U. S. Public Health Service)—To outline a method of making a survey of the visual factors of the working environment and the worker's vision and evaluating the findings in terms of visual comfort and effectiveness and eye health.

J. F. Parsons, Chairman, Niagara Mohawk Power Corp., Electric Bldg., Buffalo 3, N. Y.

H. N. Doyle, Vice-Chairman, U. S. Public Health Service, Washington 25, D. C.

Tula Brocard — L. E. Duval, Jr.
L. J. Cahill — A. L. Koven
George Clayton — R. P. Teele

LIGHT CONTROL AND EQUIPMENT DESIGN—Collect and correlate the knowledge and data on means and methods of controlling, directing, reflecting, transmitting and diffusing light and on the principles and practices of equipment design.

J. N. Robertson, Chairman, Los Angeles Dept. of Water and Power, Design and Construction Div., 405 S. Hill St., Los Angeles, Calif.

Milton Buzan, Vice-Chairman, Day-Brite Lighting, Inc., 5411 Bulwer Ave., St. Louis, Mo.

W. O. Benjamin — J. S. Hamel
Eric H. Church — J. J. McLaughlin
C. M. Holden — Maurice E. Robertson
F. C. Winkler

LIGHT SOURCES — To correlate and report available information as to the physics of light and light production and the characteristics of current light sources.

Herbert A. Anderson, Chairman, Duro-Test Corp., N. Bergen, N. J.

L. E. Barbrow — George Freeman
W. P. Carpenter — D. S. Gustin
R. D. Churchill — Walter Houston
David Cutler — E. F. Kelly
G. E. Davidson — O. Leinhard
R. B. Dull — E. H. Salter

Color Rendition

Dorothy Nickerson, Chairman, 2039 New Hampshire Ave. N. W., Washington 9, D. C.

C. N. Clark — Norman Macbeth
George Freeman — G. R. Stillwell
C. W. Jerome — Luke Thorington
D. B. Judd — A. W. Weeks
Gunter Wyszecki

MAINTENANCE — To study the elements contributing to maintenance factors; set up the framework of typical field studies to determine factors; and to stimulate the prosecution of such studies by appropriate agencies.

C. M. Holden, Chairman, Champion Lamp Works, 330 Lynnway, Lynn, Mass.

R. D. Bradley — Elmo E. Irwin
A. A. Brainerd — Howard Long
Francis Clark — William Lyons
Leo Duval — D. R. Phillips
L. M. Endres — F. J. Roche
W. C. Fink, Jr. — R. P. Teele

MERCHANDISING — (formerly Store Committee)—To study the application of light and lighting to the spaces and processes involved in the selling of goods and to report thereon.

W. H. Kahler, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio

Theodore Ake — Lester Geis
R. C. Allison — Herbert Hoffman
C. W. Clarkson — Richard Kelly
L. H. Dickelman — L. N. Lamboy
R. T. Dorsey — N. J. Sonnenfeld
Norman Falk — K. C. Welch

Service Stations and Parking Areas

E. H. Schaefer, Chairman, Wisconsin Electric

(*Continued on page 30A*)

L-M'S PTLs were used to light this enchanting scene at the Ann Morrison Memorial Park in Boise, Idaho. Eighteen equally spaced 300 watt incandescent PTL luminaires, mounted on 20-foot aluminum poles, provide soft, low-level lighting for the gardens and walks surrounding the pool.

Line Material's New Post Top Luminaire Combines Beauty and Efficient Lighting

Line Material Industries, one of the nation's leading manufacturers of outdoor lighting, has combined in the PTL (Post Top Luminaire) charming modern appearance with soft, even illumination. It is specially suited for parks, schools, playgrounds, institutional grounds, driveways, parking lots, bus stations, or wherever elegance and efficient lighting are desired.

The PTL incorporates a rigid spun-aluminum reflector, an efficient glass refractor, and a sturdy aluminum mounting base. The hinged reflector swings open for easy maintenance. It is available for mercury vapor or incandescent lamps in five IES light patterns.

Get Complete Information

L-M Bulletin 58203 completely describes the PTL unit. Get this bulletin, and complete information or engineering assistance on L-M's full line of outdoor lighting, from one of the 77 nationally located L-M Lighting or Field Engineers; or write Line Material Industries, Outdoor Lighting Division, Milwaukee 1, Wisconsin. In Canada: Canadian Line Materials, Division of McGraw-Edison Company (Canada), Limited, Toronto 13, Ontario.

THE PARKING AREA at New Orleans' fabulous Fontainebleau Motor Hotel is also lighted with Line Material Post Top Luminaires.

The new Line Material PTL is available in natural aluminum or in pastel colors for 3- or 7-inch diameter mounting. It is also available with photo control. 420

LINE MATERIAL Industries Outdoor Lighting

McGRAW-EDISON COMPANY

DISTRIBUTION TRANSFORMERS • KYLE RECLOSERS AND OIL SWITCHES • FUSE CUTOUTS AND FUSE LINKS • LIGHTNING ARRESTERS
POWER SWITCHING EQUIPMENT • PACKAGED SUBSTATIONS • CAPACITORS • REGULATORS • OUTDOOR LIGHTING
LINE CONSTRUCTION MATERIALS • PORCELAIN INSULATORS • FIBRE PIPE AND CONDUIT

McGRAW EDISON

(*Continued from page* 28A)

Power Co., 231 W. Michigan St., Milwaukee 3, Wis.

James Bale	A. L. Hart
W. G. Barr	M. C. Harsh
D. B. Brown	Frank Lago
H. A. Elwell	John Mucha
J. R. Fairweather	A. B. Winters

MOTOR VEHICLE (EXTERIOR) — To study the problems of illuminating the night operations of motor vehicles and to make suitable recommendations for promoting maximum safety and convenience including accessory illuminated signal and traffic aids.

NOMENCLATURE — To define the terms and standards of illumination, and endeavor to obtain uniformity in nomenclature.

S. K. Guth, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

E. Q. Adams	J. O. Kraehenbuehl
Abraham Abramowitz	W. F. Little
L. E. Barbrow	Philip O'Brien
C. L. Cottrell	Priscilla Presbrey
D. M. Finch	Harris Reinhardt

OFFICE — To study the lighting requirements of office lighting tasks, develop suitable lighting recommendations and report thereon.

Eric H. Church, Chairman, Lighting Products, Inc., P. O. Box 338 Highland Park, Ill.

W. S. Fisher, Secretary, General Electric Co., Nela Park, Cleveland 12, Ohio.

C. L. Amick	J. J. Neidhart
G. F. Dean	G. G. Rae
L. M. Endres	T. H. Shepherd
W. H. Johnson	John Sweatte
J. L. Kilpatrick	R. T. Waite
C. W. Macy	G. P. Wakefield
J. J. McLaughlin	E. H. Witte
R. W. McKinley	R. R. Wylie

R. L. Zahour

PROGRESS — To keep in touch with developments in the art of lighting throughout the world and prepare a yearly review of achievements in the art of illuminating engineering for inclusion in ILLUMINATING ENGINEERING.

M. K. Strang, Chairman, Curtis Lighting of Canada, Ltd., 195 Wickstead Ave., Leaside, Toronto 17, Ont.
H. A. Williams, Vice-Chairman, Rohm & Haas Co., Washington Square, Philadelphia, Pa.

Theodore Ake	W. S. Kolb
H. A. Anderson	E. A. Linsday
R. T. Dorsey (alt.)	F. J. Marriett
Norman Falk	T. C. Sargent
R. E. Faucett	S. M. Segal
John Gornet	R. P. Teele
R. E. Harz	R. F. Townsend
A. R. Jaeger	R. R. Tipton

PUBLIC CONVEYANCES — Interior Lighting — To study the application of light to all public areas in conveyances used for passenger transportation, including particularly trains, buses, ships, street railways and subways, and report thereon.

QUALITY AND QUANTITY OF ILLUMINATION, Recommendations for — To prepare recommendations of illumination levels, brightness limits and brightness relationships in form applicable to practices.

J. J. Neidhart, Chairman, The Miller Co., Meriden, Conn.

Willard Allphin	W. H. Kahler
R. D. Bradley	L. G. Parks
J. M. Chorlton	Thomas J. Seburn
E. H. Church	E. M. Strong
J. W. Griffith	M. A. Warskow
S. K. Guth	W. W. Weld

RESIDENCE — To study and report on the application of light and lighting in residences; to develop performance recommendations for residence luminaires and to prepare necessary educational aids.

W. F. Little, Chairman, 75 Dalton Rd., Yonkers 2, N. Y.

William Blitzer	Robert J. Murphy
Myrtle Fahsbender	Jan Reynolds
Helen Gibbons	Vito Russo
Benjamin Goodman	Mary B. Taepke
F. J. Marriett	H. A. Van Collie
Elizabeth A. Meehan	Mary E. Webber

Revision of "Contemporary Lighting in Modern and Traditional Interiors"

Myrtle Fahsbender, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

Kaye Leighton	Gladys Miller
	Jan Reynolds

ROADWAY — To establish the scientific principles underlying street and highway lighting; to collect data on the results of the application of such principles to actual practice; to prepare such reports thereon as will assist technicians and benefit the public.

Thomas J. Seburn, Chairman, Bureau of Highway Traffic, Strathcona Hall, Yale University, New Haven, Conn.

L. F. Heckman, Vice-Chairman, Union Metal Mfg. Co., 143 Maple Ave., N.E., Canton, Ohio.

H. E. Mason, Secretary, City Hall Annex, Room 1032, Philadelphia, Pa.

David M. Baldwin	O. W. Meissner
***James D. Blythe**	**C. R. Minors**
P. C. Box	**F. E. Moesta, Jr.**
R. P. Brotzman (EEI)	***George Nagel**
R. S. Bucher	***J. J. Oberhausen**
P. B. Clark	**O. P. Ortlieb**
W. F. Crosby	***H. W. Osborne**
A. R. Dow	***R. J. Palmer**
W. H. Edman	***K. L. Partridge**
W. B. Elmer	**Ellis E. Paul**
J. H. Fahey	***Blair E. Plowman**
D. M. Finch	**C. H. Rex**
***H. A. Friede**	**D. W. Rowten**
G. K. Glass	**F. J. Schmitt**
C. A. B. Halvorson	***L. J. Schrenk**
***M. B. Hastings**	***Murray D. Segal**
W. E. Hawkins	***S. E. Sisco**
R. M. Hoot	***J. Homer Shaw**
***Harry Hrivnatz**	**S. M. Star**
Robert Kaiser	**R. M. Swetland**
M. E. Keck	**R. P. Teele**
Charles J. Keese	**D. A. Toenjes**
G. E. Korten	**G. A. Trosper**
***R. A. Landry**	**H. F. Wall**
***Albert Lorch**	**R. C. Wey**
***R. B. Marxheimer**	**Henry Wojcik**
H. E. Mason	**R. R. Wylie**
J. F. McGough	**J. W. Young**

R. M. Zabel

*Members only in advisory capacity.

SCHOOL — To study the application of light and lighting to the spaces and processes involved in educational institutions and to report thereon.

J. M. Chorlton, Chairman, Board of Education, 155 College St., Toronto 2B, Ont.

Willard Allphin	J. L. Kilpatrick
R. D. Bradley	C. N. Laupp
L. H. Brown	H. L. Logan
H. F. Davidson	J. D. MacConnell
A. A. Eastman	B. M. McLean
W. S. Fisher	J. J. Neidhart
W. V. C. Foulks	J. F. Parsons
J. W. Griffith	R. C. Putnam
J. P. Hamel	F. K. Sampson
R. C. Hultgren	Paul Seagers
L. V. James	E. M. Strong
Chester Jarrett	H. A. Stroud
W. H. Johnson	K. C. Welch

Chalkboards

H. F. Davidson, Chairman, Curtis Lighting of Canada Ltd., 195 Wickstead Ave., Leaside, Toronto, Ont.

Electric Lighting Design

J. F. Parsons, Chairman, Niagara-Mohawk Power Corp., Electric Bldg., Buffalo 3, N. Y.

Student Vision and Scholarship

A. A. Eastman, Chairman, General Electric Co., Nela Park, Cleveland 12, Ohio.

Visual Problems

Paul Seagers, Chairman, School of Education, Indiana University, Bloomington, Ind.

SEARCHLIGHT — To study the design and application of searchlights and to report thereon.

T. I. Monahan, Chairman, Naval Material Laboratory, N. Y. Naval Shipyard, Brooklyn 1, N. Y.

Fred G. Bauer	E. B. Heyer
Ernest Boghosian	George F. Johnston
F. E. Carlson	Harold Korbel
Pierre Demoureuille	J. P. Latil
R. B. Dull	Peter Mole
Carl Egeler	T. M. Monahan
B. R. Finch	W. F. Mullis
C. J. Glass	L. R. Noffsinger
D. S. Gustin	W. A. Pennow
J. S. Haney	Don Peterson
Arthur Hatch	T. H. Projector
C. A. Hearn	S. Resnick
R. Heine-Geldern	A. P. Wasdyke

LIAISON REPRESENTATIVES

J. C. Boggs	R. S. Wiseman

Light Sources

Stewart Belden	R. L. Henderson
R. Heine-Geldern	Harold Korbel
D. S. Gustin	J. P. Latil
M. A. Hankins	S. M. Segal
Arthur Hatch	A. M. Swasey

Nomenclature

Ernest Boghosian, Chairman, Dept. of the Navy, Bureau of Ships, Washington, D. C.

H. Korbel

Optics

D. Peterson, Chairman, Bausch & Lomb Optical Co., Rochester 2, N. Y.

W. Drake	B. R. Finch
	E. B. Meyer

Testing Procedures

T. H. Projector, Chairman, 3304 Edgewood Rd., Kensington, Md.

Sidney Feldman	S. M. Segal
	R. S. Wiseman

Visibility of Targets and Sources

J. C. Boggs	John Johnson

SIGN LIGHTING — To study the lighting of signs, both exterior and interior and report thereon.

C. N. Laupp, Chairman, Wisconsin Electric Power Co., 231 W. Michigan St., Milwaukee, Wis.

M. R. Ely	W.H. Kahler
R. E. Faucett	E. E. Kinney
H. B. Fletcher	M. F. McCann
A. L. Hart	R. J. Neu

SPORTS AND RECREATIONAL AREAS — To develop current recommended practices for lighting sports and recreational areas; study techniques of application including effects on player performance and spectator visibility and report thereon.

Wallace W. Weld, Chairman, Revere Electrical Mfg. Co., 7420 Lehigh Ave., Chicago 48, Ill.

James Bale	W. P. Graham
D. B. Brown	Howard Long
R. H. Dickinson	Edward Machtinger
R. T. Dorsey	D. E. Trefry
R. E. Faucett	H. M. White

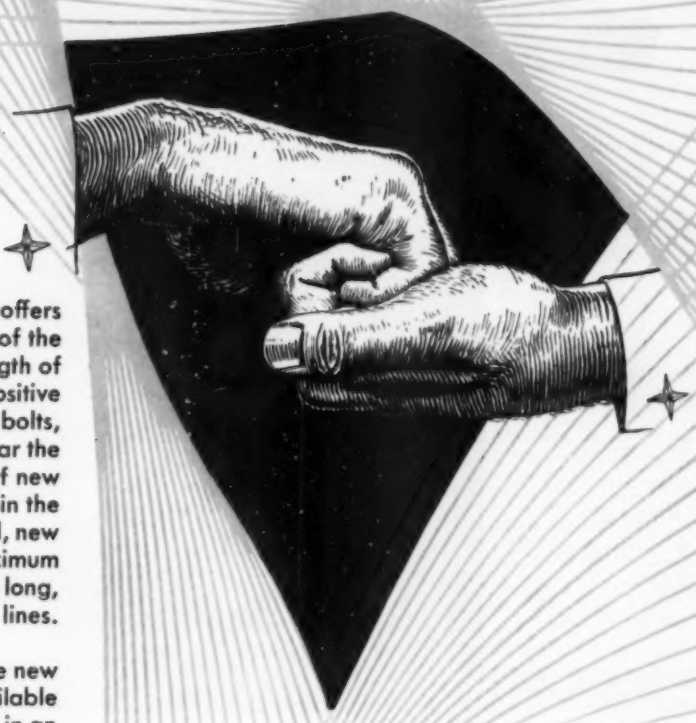
TESTING PROCEDURES — To prepare standard test procedures for illumination characteristics of light sources, lighting equipment and illumination materials and to report thereon.

A. W. Weeks, Chairman, Champion Lamp Works, 330 Lynnway, Lynn, Mass.

(*Continued on page* 33A)

simplicity — the key to positive light seal

new Smithcraft SPEEDOMATIC TROFFERS



New Smithcraft Speedomatic troffers utilize the principle of the interlocking grip, the full length of the door frame, assuring positive light seal. There are no visible bolts, catches or hinges to mar the architectural beauty of new Speedomatic troffers. Framed in the ceiling by a single width of metal, new Speedomatic troffers offer maximum illuminated areas and long, free-flowing precise lines.

Today's most versatile troffer, the new Smithcraft Speedomatic is available in one- and two-foot wide widths, in an abundance of sizes and shieldings that add up to 5366 individual choices in one complete troffer line. This unique versatility allows the architect complete freedom of expression in lighting arrangements.

Specifying and ordering of Speedomatic is extremely simple — four basic types fit over 100 ceiling systems (as listed in Smithcraft's complete Ceiling Index).

eye-li

For complete information on versatile, trim Speedomatic troffers, and Smithcraft's Ceiling Index, write for complete 30-page catalog and price list.

+ Light-conditioning by Smithcraft — America's finest fluorescent lighting

Smithcraft
LIGHTING
CHELSEA 50, MASSACHUSETTS

NOW UNI-FRAME BECOMES A COMPLETE LENS BOX LINE

with new 10-inch size, new diffusing glass bowl and new splay trims. Choose from 24 possible UNI-FRAME combinations. For details, call your Day-Brite representative listed in the Yellow Pages or write

DAY-BRITE LIGHTING, INC., ST. LOUIS 15, MISSOURI • SANTA CLARA, CALIFORNIA

NATION'S LARGEST MANUFACTURER OF COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT

DECIDEDLY BETTER
DAY-BRITE
LIGHTING FIXTURES

A-584

choice of
SIZE

10-inch for 150-watt lamp at new lower price

12-inch size for 200- or 300-watt lamp

choice of
FINISH

White Enamel
Aluminum
Brass

Basic UNI-FRAME lens box
(Patents Pending)

choice of
SPLAY
(OPTIONAL)

White Enamel
Aluminum
Brass Finish

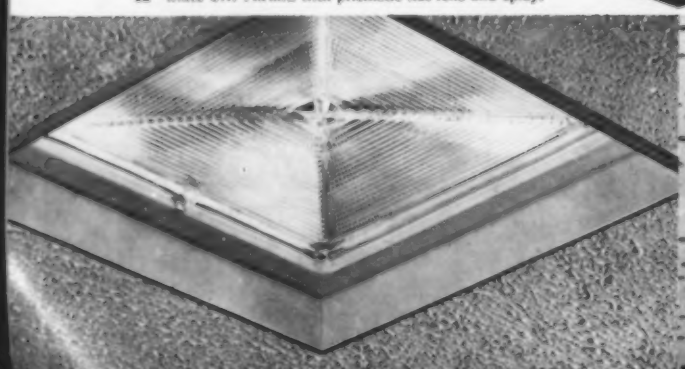
choice of
LENS

Diffusing Glass Bowl of Double-Tuf® ceramic-coated PYREX®

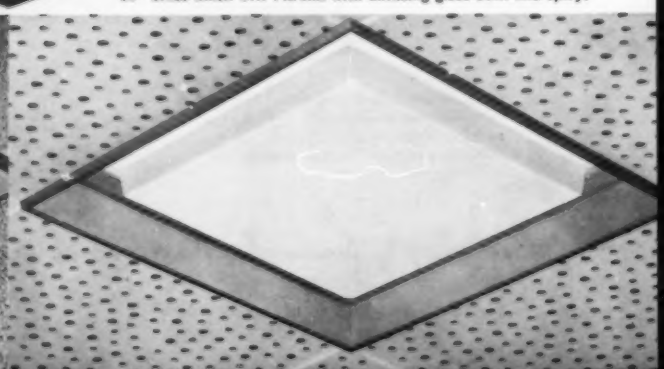
Prismatically-accurate Flat Lens of fully tempered PYREX®

®Reg. Trade Mark of Corning Glass Works

12" white UNI-FRAME with prismatic flat lens and splay.



10" brass finish UNI-FRAME with diffusing glass bowl and splay.



(Continued from page 30A)

Elden H. Witte, Vice-Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

Paul H. Lamson, Secretary, Wheeler-Fullerton Lighting Div., Hanson, Mass.

J. E. Bock	Phelps Meaker
R. D. Bradley	G. A. Meyers
R. C. Dahl	W. E. Murray
G. E. Davidson	F. M. Neal
D. W. Davis	Jack D. Pomon
W. V. C. Foulks	Priscilla Presbrey
J. S. Franklin	Luke A. Provenzano
W. G. Hill	E. H. Salter
G. A. Horton	R. L. Smith
W. H. Houston	Kurt Stauffert
B. F. Jones	R. P. Teele
A. E. Krawcek	W. W. Weld
T. H. Leister	S. W. Wilson (alt.)
J. H. McCulloch	P. L. Young

General Guide on Photometry

R. P. Teele, Chairman, National Bureau of Standards, Washington, D. C.

Guide for Determination and Specification of Diffusion and Hiding Power of Fixture Diffusing Materials

J. H. McCulloch, Chairman, Independent Testing Laboratories, 1928 Fourteenth St., Boulder, Colo.

R. D. Bradley — F. M. Neal
E. H. Witte

Guide for Electrical & Photometric Measurements of Fluorescent Lamps

G. A. Meyers, Chairman, Sylvania Electric Products Inc., 75 Sylvan St., Danvers, Mass.

G. E. Davidson	T. H. Leister
J. S. Franklin	Priscilla Presbrey
W. G. Hill	E. H. Salter
W. H. Houston	Kurt Stauffert
E. M. Kooker	A. W. Weeks

S. W. Wilson

Guide for Electrical and Photometric Measurements of Mercury Lamps

J. S. Franklin, Chairman, General Electric Co., Hendersonville, N. C.

Guide for Interpretation of Test Data and Results

S. F. Downey, Chairman, Wheeler-Fullerton Lighting Div., Franklin Research Corp., 275 Congress St., Boston, Mass.

R. D. Bradley	A. E. Krawcek
G. E. Davidson	T. H. Leister
D. W. Davis	Phelps Meaker
D. M. Finch	G. A. Meyers
W. V. C. Foulks	E. H. Salter
J. S. Franklin	R. L. Smith
G. A. Horton	E. H. Witte

Guide for Investigation of Methods and Techniques of Measuring and Reporting Tests of Reflector Type Lamps

Priscilla Presbrey, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

R. D. Churchill	S. M. Gray
G. E. Davidson	Harry Koth
C. D. Foss	A. E. Krawcek
J. S. Franklin	E. H. Salter
G. A. Freeman	Kurt Stauffert

Guide for Life Performance Testing of Fluorescent Lamps

Priscilla Presbrey, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

G. E. Davidson	E. H. Salter
W. G. Hill	G. R. Spears
W. H. Houston	Kurt Stauffert
E. M. Kooker	A. W. Weeks

S. W. Wilson

Guide for Method of Measurement of Fluorescent Lamp Starting

G. A. Meyers, Chairman, Sylvania Electric Products Inc., 75 Sylvan St., Danvers, Mass.

T. H. Heine	E. M. Kooker
W. H. Houston	Kurt Stauffert

A. W. Weeks

Guide for Outdoor Illumination Tests

J. S. Franklin, Chairman, General Electric Co., Hendersonville, N. C.

Guide for Photometric Testing of Floodlights of 10°-160° Total Beam Spread (1950)

J. S. Franklin, Chairman, General Electric Co., Hendersonville, N. C.

G. A. Horton	E. H. Salter
A. E. Krawcek	Kurt Stauffert
Jack D. Pomon	W. W. Weld
L. A. Provenzano	E. H. Witte

Guide for Photometric Testing of Fluorescent Luminaires

G. A. Horton, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio.

R. D. Bradley	J. H. McCulloch
G. E. Davidson	Phelps Meaker
Donald W. Davis	F. M. Neal
D. M. Finch	E. H. Salter
W. V. C. Foulks	R. L. Smith
P. H. Lamson	W. W. Weld

E. H. Witte

Guide for Photometric Testing of Mercury, Sodium and Incandescent Street Lighting Luminaires

T. H. Leister, Chairman, Line Materials Industries, 12th & Madison Avenues, South Milwaukee, Wis.

G. E. Davidson	L. A. Provenzano
J. S. Franklin	E. H. Salter
G. A. Horton	R. L. Smith
F. M. Neal	W. W. Weld
J. D. Pomon	P. L. Young

Guide for Photometric Testing of Outdoor Luminaires

J. S. Franklin, Chairman, General Electric Co., Hendersonville, N. C.

Guide for Photometry of Searchlights

A. E. Krawcek, Chairman, Crouse-Hinds Co., Syracuse 1, N. Y.

Guide for Reporting Lighting Equipment Engineering Data

E. H. Witte, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

Guide for Testing Filament Luminaires

E. H. Salter, Chairman, Electrical Testing Laboratories, 2 East End Ave., N. Y., N. Y.

Guide for Use of Photoelectric Portable Photometers (1937)

G. A. Horton, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio.

Phelps Meaker — G. A. Meyers

Practical Guide for Brightness Measurements

P. H. Lamson, Chairman, Wheeler-Fullerton Lighting Div., Hanson, Mass.

R. D. Bradley	B. F. Jones
G. E. Davidson	J. H. McCulloch
D. W. Davis	L. A. Provenzano
D. M. Finch	E. H. Salter
G. A. Horton	R. P. Teele

E. H. Witte

Practical Guide to Colorimetry of Light Sources

R. P. Teele, Chairman, National Bureau of Standards, Washington, D. C.

M. H. Gabriel	L. A. Provenzano
W. H. Houston	A. W. Weeks

Practical Guide to Photometry

R. D. Bradley, Chairman, Day-Brite Lighting Inc., 5411 Bulwer Ave., St. Louis 7, Mo.

G. E. Davidson	T. H. Leister
W. G. Hill	L. A. Provenzano
G. A. Horton	Kurt Stauffert
B. F. Jones	P. L. Young

A. W. Weeks

Study Project A—To establish methods of testing heavily loaded lamps and auxiliary equipment with respect to distribution and physical orientation.

G. A. Horton, Chairman, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio

G. E. Davidson	G. A. Meyers
M. H. Lakness	R. L. Smith

Study Project B—To establish methods of measurement and temperature and drafts with respect to fluorescent lamps and auxiliary equipment.

G. A. Meyers, Chairman, Sylvania Electric Products Inc., 75 Sylvan St., Danvers, Mass.

R. D. Bradley	Philip R. Herrick
G. E. Davidson	W. H. Houston
J. S. Franklin	A. W. Weeks

Study Project C—To follow ballast testing techniques.

R. D. Bradley, Chairman, Day-Brite Lighting, Inc., 5411 Bulwer Ave., St. Louis, Mo.

G. E. Davidson	J. H. McCulloch
Paul H. Lamson	E. H. Salter

A. W. Weeks

THEATRE-TELEVISION — To study and report on the lighting for theatrical presentations and for production of television programs.

Joel E. Rubin, Chairman, Kliegl Bros., 321 W. 50th St., New York, N. Y.

T. W. Butler	T. Nutt
F. E. Carlson	K. M. Palius
A. R. Davis	W. E. Richardson
D. W. Frick	A. C. Risser
T. Fuchs	Jean Rosenthal
W. Garrett, Jr.	H. D. Sellman
R. Kuntner	G. C. Smedberg
H. R. More	R. G. Williams
W. O'Meara	W. R. Wilson

IES-SMPTE Recommended Practice

A. C. Risser, Chairman, University of Wichita, Wichita, Kans.

D. W. Frick — G. T. Howard

Lighting for School Theatres

R. G. Williams, Chairman, Century Lighting, Inc., 521 West 43rd St., New York 36, N. Y.

A. W. Boylen	T. Fuchs
A. R. Davis	A. C. Risser

H. D. Sellman

Lighting for the Vidicon Camera

H. R. More, Chairman, Kliegl Bros., 321 West 50th St., New York, N. Y.

C. S. Bramley	W. O'Meara
D. W. Frick	K. M. Palius

R. L. Zahour

Theatre Lighting Glossary

A. R. Davis, Chairman, Ariel Davis Mfg. Co., 3687 S. State St., Salt Lake City, Utah.

OFFICIAL REPRESENTATIVES TO OTHER ORGANIZATIONS

AMERICAN STANDARDS ASSOCIATION SECTIONAL COMMITTEES

(C. L. Crouch, Technical Director, alternate representative to all)

Building Exits Code, A9

H. E. D'Andrade

American Standard Practice for Industrial Lighting, A11

L. G. Parks

American Standard Practice for School Lighting, A23

J. M. Chorlton

Building Code Requirements for Light and Ventilation, A53

J. W. Griffith

National Electrical Code, C1 Panel 2, 3 and 10

G. E. Shoemaker

(Continued on page 34A)

Committee Personnel

(*Continued from page 33A*)

Definitions of Electrical Terms, C42
Priscilla Presbrey

Dimensional and Operational Standardization of Electrical Lamps and Auxiliaries for

Gaseous Discharge Lamps, C78
Thomas S. Kelly

Inspection Requirements for Motor Vehicles, D7.1
R. P. Teele

Office Standards, X2
(to be appointed)

Letter Symbols and Abbreviations for Science and Engineering, Y10
Priscilla Presbrey

Drawing and Drafting Room Practice, Y14
Priscilla Presbrey

Graphic Symbols and Abbreviations for Use on Drawings, Y32
Priscilla Presbrey

Preferred Numbers, Z17
D. E. Spencer

Safety Color Code, Z53
W. H. Kahler

Colors for Industrial Apparatus Equipment, Z55
W. H. Kahler

Standardization of Optics, Z58
Priscilla Presbrey

Uniform Industrial Hygiene Standards, Z62
L. G. Parks

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, GOVERNING BOARD
S. K. Guth — C. L. Crouch, Alternate

ARMED SERVICES NRC VISION COMMITTEE
C. L. Crouch

INDUSTRY COMMITTEE IN CONNECTION WITH HANDBOOKS OF INTERIOR WIRING DESIGN
A. C. Bredahl — G. E. Shoemaker

INTER-SOCIETY COLOR COUNCIL
Norman Macbeth,* Chairman

R. C. Allison	H. L. Logan
C. N. Clark	J. A. Meacham
G. F. Dean	Gladys Miller
C. W. Jerome*	Paul Seagers
W. F. Little*	D. E. Spencer

*Voting delegates

NATIONAL COMMITTEE ON UNIFORM TRAFFIC LAWS AND ORDINANCES
R. P. Teele

Vehicle Lighting
R. P. Teele — V. J. Roper, Alternate

NATIONAL RESEARCH COUNCIL

Division of Engineering and Industrial Research
C. A. Douglas

Highway Research Board
pending

National Academy of Sciences
A. F. Wakefield

National Academy of Sciences, Advisory Board on Critical Tables
W. E. Forsythe

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS
Herbert Kliegl

CANADIAN NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON ILLUMINATION
J. W. Bateman — George Watters

U. S. NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON ILLUMINATION

H. R. Blackwell	Leonard C. Mead
C. L. Crouch	E. M. Strong
Glenn A. Fry	G. J. Taylor
W. P. Lowell, Jr.	M. N. Waterman

Local Officers

(*Continued from page 20A*)

Secretary—J. Roy Jones, Westinghouse Lamp Division, 600 St. Paul Ave., Los Angeles, Calif.

Southern Colorado Chapter—Inter-Mountain Region

Chairman—Kenneth J. Stines, 222 S. Victoria Ave., Pueblo, Colo.
Secretary—James E. Parker, Parker & Associates, 316 S. Main, Pueblo, Colo.

South Plains Chapter—Southwestern Region

Chairman—Russell A. Trawick, Texas Electric Service Co., P. O. Box 3547, Odessa, Texas.
Secretary—Robert Brasher, 2519 2nd St., Lubbock, Texas.

Suwannee River Chapter—Southeastern Region

Chairman—Neil A. Gleason, Georgia Power Co., Valdosta, Ga.
Secretary—To Be Appointed.

Tar Heel Section—Southeastern Region

Chairman—T. Llew Cordle, J. N. Pease & Co., 2925 Independence Blvd., Charlotte, N. C.
Secretary — Everett D. Stevens, Carolina Power & Light Co., Raleigh, N. C.

Tennessee Valley Section—South Central Region

Chairman—James R. Harrell, Tafel Electric & Supply Co., 401 Sixth Ave., South, Nashville, Tenn.
Secretary — William E. Jones, Nashville Electric Service, 1214 Church St., Nashville, Tenn.

Toronto Section—Canadian Region

Chairman—R. P. Lindsay, 267 The Donway West, Don Mills, Ont.
Secretary—A. J. Brown, 8 Thorn Lane, Don Mills, Ont.

Twin City Section—Midwestern Region

Chairman — John C. Newhouse, Northern States Power Co., 15 South 5th, Minneapolis, Minn.
Secretary—Charles Duepner, B.M.D. & R., Inc., 7020 Walker St., St. Louis Park, Minneapolis, Minn.

Twin Ports Chapter—Midwestern Region

Chairman—Theodore A. Gunderson, Superior Water, Light & Power Co., 1230 Tower Ave., Superior, Wis.
Secretary—Arthur Johnson, 4720 Colorado St., Duluth, Minn.

Utah Section—Inter-Mountain Region

Chairman—J. Homer Shaw, Utah Power & Light Co., Box 899, Salt Lake City, Utah.
Secretary—Homer S. Sherwood, Utah Power & Light Co., Box 899, Salt Lake City, Utah.

Vancouver Island Chapter—Pacific Northwest Region

Chairman—Tom Mawson, Mawson Gage Ltd., 619 Chatham, Victoria, B. C.
Secretary—Walter E. Beek, B. C. Electric Co., Ltd., 820 Pandora Ave., Victoria, B. C.

Virginia Section—East Central Region

Chairman — Warren G. Cornelius, 2112 Whitewood Road, Richmond, Va.
Secretary—R. W. Thomas, Chewning & Welmer, Inc., P. O. Box 4167, Richmond, Va.

Western Michigan Section—Great Lakes Region

Chairman—Lewis L. Nurnberger, Consumers Power Co., 821 Hastings St., Traverse City, Mich.
Secretary—James Q. Miller, 1183 Hampden Road, Muskegon, Mich.

Western New York Section—Great Lakes Region

Chairman—Tunis E. Barhite, Jr., New York State Electric & Gas Corp., 115 Main St., Lockport, N. Y.
Secretary—William J. McCarthy, Niagara Mohawk Power Corp., 535 Washington, Buffalo, N. Y.

Winnipeg Chapter—Canadian Region

Chairman—A. C. Burnard, 198 Lipton St., St. James, Man.
Secretary—E. T. Battle, J. A. Wilson Lighting & Display, Ltd., 626 Campbell St., Winnipeg, Man.

Yankee Chapter—Northeastern Region

Chairman — Frank P. Hayden, 1312 Page Blvd., Springfield, Mass.
Secretary — Albert Lacas, Western Massachusetts Electric Co., 46 Engle St., Pittsfield, Mass.

Yosemite Chapter—South Pacific Coast Region

Chairman—Donald E. Fisher, Pacific Gas & Electric Co., P. O. Box 180, Selma, Calif.
Secretary—Edward F. Bowen, City of Fresno, Fresno City Hall, 2326 Fresno St., Fresno, Calif.

I.E.S. National Technical Conferences

1960—September 11-16—Penn Sheraton Hotel, Pittsburgh, Pennsylvania

1961—September 24-29—Chase Park Plaza Hotel, St. Louis, Missouri

1962—September 9-14—Statler-Hilton Hotel, Dallas, Texas

1963—September 8-13—Sheraton-Cadillac Hotel, Detroit, Michigan

NO "FIFTH AMENDMENT" HERE

Every sub-assembly must testify—must prove its perfection in Jefferson's intensive quality control system—your guarantee of getting the light, the lamp life and the ballast dependability you pay for.

The ballasts you buy can only perform as efficiently as their weakest part. The condenser, the coil, the basic steel core, plus many other components, can cause sub-standard and sporadic operation.

This is why JEFFERSON conducts the most intensive quality control procedure in the industry—a system that is 100% complete.

Example: at midpoint during manufacture, coils have been checked, so have cores. But how will they operate in conjunction with each other? At left, a production line core-coil test board continually checks and determines adherence of every coil-core sub-assembly to specific electrical requirements. Result: you know every JEFFERSON ballast you buy will obtain full rated light output from the lamp it activates—and both lamp and ballast will last longer.

Here Jefferson ballasts get off to the right start. While almost all ballast makers test the electrical characteristics of silicon "core" steel, Jefferson actually cuts the steel into core-size and core-shape laminations. After they have been carefully weighed, laminations are electrically tested.

Ask your Jefferson representative to show you how the industry's only 100% quality control system gives your fluorescent lamp installation the best chance for success.

Jefferson

FLUORESCENT BALLASTS

Jefferson Electric Company, Bellwood, Illinois

new APPLETON all aluminum floodlights

for ALL the light you need
WHEN you need it . . . WHERE you need it

Permanent Efficiency is Built-In to this Latest APPLETON-Engineered Addition to the Growing Line of APPLETON Lighting Equipment

6050 SERIES

Trouble-free nighttime visibility for small or large areas is yours with APPLETON All Aluminum Floodlights. The adjustable focusing mechanism allows movement of the lamp forward or backward for greater selection of beam spreads. Easy to mount, simple to focus and rugged throughout, these new floodlights are ideal for shipyards, storage areas, warehouses, lumber yards, construction areas, building exteriors, etc.

Features of this practical floodlight include: wide range of focusing through unique, adjustable dial mechanism; a free swinging cast aluminum cover ring and heat-resistant lens assembly for quick lamp changing and maintenance; weather-tight construction; horizontal and vertical degree adjustment; lead-in wiring furnished with water-tite cord gland. Optional use of 300 or 500 watt incandescent Mogul base lamps or mercury vapor lamps. Wide variety of accessories for pole and wall mounting.

For Buildings

For Railroad Yards

For Construction Areas

Sold Through Franchised Distributors Only

For full details on this latest addition to the complete APPLETON line of floodlights incorporating the best of APPLETON engineering skills and years of experience . . . write today!

APPLETON ELECTRIC COMPANY
1701 Wellington Avenue, Chicago 13

Also Manufacturers of:

"ST" Series Connectors

Malleable Iron Unilets

Industrial Lighting Equipment

Automatic Reelites

PUBLICATIONS

of the

ILLUMINATING
ENGINEERING
SOCIETY

1860 Broadway, New York 23, N. Y.

The Publications of the Illuminating Engineering Society listed here summarize the vast amount of research, investigation and discussion of hundreds of qualified members of the Society working on technical committees, and carry the full approval and authority of the Illuminating Engineering Society.

I.E.S. Publications are available, in single copies as priced, to anyone requiring knowledge of the newest in lighting application and the supporting technical information. Should quantities be desired for further distribution, such as for educational or promotional purposes, prices may be obtained by writing Publications Office.

This is your order form. Indicate number of copies ordered before each item; fill in name and address on back of form.

— **HB-3 I.E.S. LIGHTING HANDBOOK**
Third Edition **$10**

Add 50¢ for mailing outside U. S. and Canada. Special registered single copy price to I.E.S. members, $7.50; unless previously ordered. Quantity prices on request. Write for brochure.

NEWEST of famous I.E.S. Lighting Handbooks. Published March 1959. Over 1100 pages latest information on lighting techniques, applications and theory . . . plus equipment data. Includes all new lighting levels developed from Blackwell research studies. All-new index and cross-index. Application sections rearranged for subject headings; 25 sections in all, many new. Complete revision of previous two editions; more comprehensive, easier to use than ever.

Designed for use of lighting engineers and specialists; lighting consultants, architects, designers . . . anyone who plans, installs, of manufactures lighting systems or equipment.

I.E.S. RECOMMENDED LIGHTING PRACTICES

These booklets are the complete, standard recommendations for lighting the prescribed areas, and are among the most comprehensive and important of all Society publications. As indicated, some of these recommendations are the work of committees of the American Standards Association, with collaboration by appropriate committees of the I.E.S. All have the approval of the Council of the Illuminating Engineering Society, and the the latest official I.E.S. recommendations.

In general, the information contained in these Recommended Lighting Practices covers completely the area shown in the title. Included in the data are suggested types of lighting systems and luminaires; levels for general lighting and for specific areas; analyses of seeing tasks; and other information essential to lighting the area and of value to lighting engineers and specialists, architects, construction people and others. Each practice is fully illustrated with charts and photographs.

— **RP-1 OFFICE LIGHTING (1956)**
I.E.S. Recommended Practice 32 pp. 50c

— **RP-4 LIBRARY LIGHTING (1950)**
I.E.S. Recommended Practice 16 pp. 50c

— **RP-5 DAYLIGHTING (1950)**
I.E.S. Recommended Practice 40 pp. 50c

— **RP-7 INDUSTRIAL LIGHTING (1953)**
American Standard Practice 40 pp. 50c

— **RP-8 STREET AND HIGHWAY LIGHTING (1953)**
American Standard Practice 32 pp. 50c

— **RP-9 SUPPLEMENTARY LIGHTING (1955)**
I.E.S. Recommended Practice 16 pp. 50c

— **RP-10 PROTECTIVE LIGHTING (1956)**
American Standard Practice 20 pp. 50c

— **RP-11 RESIDENCE LIGHTING (1953)**
I.E.S. Recommended Practice 44 pp. $1.00

RP-2 (Stores & Other Merchandising Areas), RP-3 (School Lighting) and RP-6 (Sports Lighting) are out of print. When revised publications are available they will again appear on this list.

I.E.S. COMMITTEE REPORTS

Lighting recommendations based upon studies (research, surveys of current practice, and experimental installations) of I.E.S. Committees and Subcommittees covering all phases of lighting. Completely illustrated, these reports contain detailed information on many lighting problems peculiar to the industry or operation involved as well as providing general data as to lighting systems and luminaires; recommended quantity and quality of illumination; and analyses of specific seeing tasks.

— **CP-1 LIGHTING FOR WOOLEN AND WORSTED TEXTILE MILLS 12 pp.** 50c

— **CP-2 LIGHTING FOR MACHINING OF SMALL METAL PARTS 16 pp.** 50c

— **CP-3 LIGHTING FOR FLOUR MILLS 8 pp.** 50c

— **CP-4 LIGHTING FOR CANNERIES 36 pp.** 50c

— **CP-5 LIGHTING FOR BAKERIES 16 pp.** 50c

— **CP-6 LIGHTING OF CENTRAL STATION PROPERTIES, CONTROL AND LOAD DISPATCH ROOMS 20 pp.** 50c

— **CP-7 LIGHTING FOR CENTRAL STATION HIGH BAY AREAS 12 pp.** 30c

— **CP-8 LIGHTING OUTDOOR LOCATIONS OF CENTRAL STATION PROPERTIES 16 pp.** 40c

— **CP-9 LIGHTING INDOOR LOCATIONS OF CENTRAL STATION PROPERTIES 20 pp.** 40c

— **CP-10 LIGHTING FOR STEEL MILLS PART I: OPEN HEARTH 8 pp.** 50c

— **CP-11 LIGHTING FOR FOUNDRIES 16 pp.** 50c

— **CP-13 LIGHTING TRAFFIC TUNNELS AND UNDERPASSES 16 pp.** 50c

— **CP-14 CONTEMPORARY LIGHTING IN MODERN AND TRADITIONAL INTERIORS 64 pp.** $1.00
Combines recommended residence lighting techniques with good decoration, written in layman's language and completely illustrated. Shows all types of lighting equipment, both installed and portable, recommended color combinations, from Colonial to Modern interiors.

— **CP-15 FUNCTIONAL VISUAL ACTIVITIES IN THE HOME 12 pp.** 25c
Provides much of the technical material supporting the combination of good decoration with lighting in CP-14 above. Extremely useful to lighting equipment designers, engineers, and because of the numerous sketches and measurements, non-technical people as well.

— **CP-16 CURRENT LIGHTING PRACTICE FOR TELEVISION PRODUCTION 8 pp.** 15c

— **CP-17 PROGRESS IN TELEVISION STUDIO LIGHTING Addenda to CP-16 4 pp.** 10c

— **CP-18 CURRENT LIGHTING PRACTICE FOR COLOR TELEVISION PRODUCTION 4 pp.** 10c

— **CP-19 LIGHTING FOR COMMERCIAL KITCHENS 8 pp.** 15c

— **CP-20 LIGHTING FOR HOTELS 42 pp.** 70c

CP-12 (Transportation Lighting) is out of print. When revised publication is available it will again appear on this list.

I.E.S. LIGHTING DATA SHEETS

Each I.E.S. Lighting Data Sheet describes an actual, outstanding lighting installation, complete with photographs, drawings and engineering data. They are published in a series of 24 sheets each year, and current sheets cover such subjects as lighting for metalworking, textile, automobile and other industries; schools; stores; offices; drafting rooms; churches; auditoriums; banks; museums; residences; indoor and outdoor recreational areas; streets and highways; and other special applications.

Printed on heavy gloss paper, punched for standard ring binder, data sheets are an excellent "idea" file for lighting people, consulting engineers and architects; ideal for promotional distribution by manufacturers and electric utilities.

I.E.S. Lighting Data Sheets are delivered throughout each year in groups of eight; three mailings for the entire 24-sheet series. First eight of each series are mailed for delivery in June; second eight in October; final eight in February of following year. Subscription, 24 sheets per set, $1.25; 10 or more sets, $1.00 each. Prices on minimum quantities of 100 individual sheets upon request to this office.

__ **XXIV Series,** 24 sheets **$1.25**
The current 1959 Series; orders now being accepted for delivery as outlined above.

__ **XXIII Series,** 24 sheets **$1.25**

__ **XXII Series,** 24 sheets **$1.25**

__ **LD-1 15 HOME LIGHTING IDEAS** 15 sheets **$1.00**
Attractively packaged, 15 home lighting data sheets, gathered and prepared especially for this publication.

__ **LD-2 HOME LIGHTING IDEAS FOR KITCHENS AND BATHROOMS** 10 sheets **50c**
Special packet of ten new home lighting data sheets, showing modern lighting for new and remodelled kitchen and bathroom areas; an important addition to any home lighting idea library.

__ **LD-3 DECORATIVE HOME LIGHTING IDEAS** 14 sheets **$1.00**
Packet of 14 home lighting data sheets each featuring an outstanding idea for decorating with light; do-it-yourself instructions for fireplace, wall niche, shelves, drapery wall, etc.
(Sheets in LD-1, LD-2 and LD-3 not included in annual Series.)

EDUCATIONAL

__ **ED-1 LABORATORY ACTIVITIES WITH LIGHT** (1959) 42 pp. **$1.00**
Attractively prepared booklet for secondary school students. Supplements physics or science texts with 12 laboratory experiments specifically on light and lighting; easily performed with minimum equipment. Designed to interest young people in lighting and lighting careers.

LIGHT MEASUREMENT & TESTING

__ **LM-1 GUIDE FOR ELECTRICAL MEASUREMENTS OF FLUORESCENT LAMPS** American Standard 4 pp. **35c**

__ **LM-2 I.E.S. GUIDE FOR ELECTRICAL MEASUREMENTS OF MERCURY VAPOR LAMPS** 4 pp. **10c**

__ **LM-3 I.E.S. GUIDE FOR LIFE PERFORMANCE TESTING OF FLUORESCENT LAMPS** 2 pp. **10c**

__ **LM-4 GUIDE FOR PHOTOMETRIC TESTING OF FLOODLIGHTS OF 10 TO 100 DEGREES TOTAL BEAM SPREAD** 16 pp. **90c**

__ **LM-5 GUIDE FOR OUTDOOR ILLUMINATION TESTS** 6 pp. **25c**

__ **LM-6 GENERAL GUIDE TO PHOTOMETRY** 24 pp. **60c**

__ **LM-7 CALCULATING COEFFICIENTS OF UTILIZATION** 36 pp. **50c**

__ **LM-8 WORK SHEETS FOR LM-7** 8 pp. ..... **per set 5c**

__ **LM-9 I.E.S. GUIDE FOR PHOTOMETRIC MEASUREMENTS OF FLUORESCENT LAMPS** 8 pp. **15c**

__ **LM-10 I.E.S. GUIDE FOR PHOTOMETRIC TESTING OF OUTDOOR FLUORESCENT LUMINAIRES** 8 pp. **15c**

__ **LM-11 I.E.S. GUIDE FOR PHOTOMETRIC TESTING OF SEARCHLIGHTS** 8 pp. **15c**

__ **LM-12 I.E.S. GUIDE FOR MEASURING AND REPORTING DAYLIGHT ILLUMINATION** 4 pp. **10c**

__ **LM-13 REPORTING PHOTOMETRIC PERFORMANCE OF INCANDESCENT FILAMENT LIGHTING UNITS USED IN THEATER AND TELEVISION PRODUCTION** Recommended Practice 8 pp. **25c**

Do not detach. Mail entire form. New list will accompany invoice.

ORDER FOR I.E.S. PUBLICATIONS

To: ILLUMINATING ENGINEERING SOCIETY
Publications Office
1860 Broadway, New York 23, N. Y.

Date .....

Send to me at the address shown below copies of I.E.S. Publications indicated elsewhere on this list:

(Please print or type)

Name ..... If I.E.S. Member Your Section/Chapter .....

.....

Street .....

City ..... Zone ..... State .....

☐ My check (m.o.) enclosed. ☐ Bill me.

For orders totalling $2 or less, please enclose check, money order or stamps with order. Prepayment will expedite handling and shipment to you.

(Printed in U.S.A.)

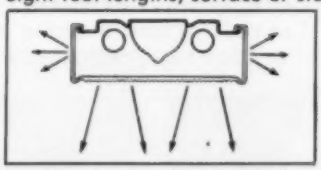
THESE AUTHORIZED LIGHTOLIER DISTRIBUTORS STOCK PRISMALUX BY LIGHTOLIER

ALABAMA
Birmingham:
Mayer Elec. Sup. Co.
ARIZONA
Phoenix:
Brown Wholesale Elec.
CALIFORNIA
San Francisco:
California Elec. Sup. Co.
COLORADO
Denver:
Central Elec. Sup. Co.
CONNECTICUT
Bridgeport:
B. M. Tower Co., Inc.
Hartford:
Beacon Light & Sup. Co.
New Haven:
Grand Light & Sup. Co.
New London:
United Elec. Sup. Co.
Stamford:
Marie Co.
Waterbury:
Starbuck Sprague Co.
Suburban Supply Co.
DISTRICT OF COLUMBIA
Washington:
Maurice Elec. Sup. Co.
National Elec. Wholesalers
FLORIDA
Miami:
Farrey's Whlse. Hdwe. Co.
GEORGIA
Atlanta:
Electrical Wholesalers
Noland Co.
Augusta:
Hart Electric Sup. Co.
ILLINOIS
Chicago:
Efengee Elec. Sup. Co.
Englewood Elec. Sup. Co.
Harris Elec. Sup. Co. Inc.
Hyland Elec. Sup. Co
Metropolitan Elec. Sup.
Steiner Elec. Co.
Wholesale Elec. Sup. Co.
Elgin:
Fox Elec. Sup. Co.
Rockford:
Englewood Elec. Sup. Co.
Springfield:
Springfield Elec. Sup. Co.
INDIANA
Ft. Wayne:
Wesman-Yamelle Co.
Gary:
Englewood Elec. Sup. Co
South Bend:
Englewood Elec. Sup. Co.
IOWA
Des Moines:
Weston Lighting, Inc.
KANSAS
Kansas City:
W. T. Foley Elec. Co.
KENTUCKY
Louisville:
Henry L. Ruff Co.
LOUISIANA
Baton Rouge:
Electrical Wholesalers Inc.
New Orleans:
Interstate Elec. Co.
MAINE
Bangor:
Standard Elec. Co.
Portland:
Holmes Elec. Supply Co.
MARYLAND
Baltimore:
Excello Public Serv. Corp.
Salisbury:
Artcraft Elec. Sup. Co.
MASSACHUSETTS
Boston:
Mass. Gas & Elec. Light Co.
Henry L. Wolfers, Inc.
Pittsfield:
Carr Supply Co.
Springfield:
Eastern Elec. Sup. Co.
Worcester:
Atlantic Elec. Sup. Co.
Benjamin Elec. Sup. Co.
MICHIGAN
Detroit:
Madison Elec. Co.
Michigan Chandelier Co.
Flint:
Bowditch Co.
Grand Rapids:
Purchase Elec. Sup. Co.
Jackson:
Electric Wholesale Sup. Co.
Pontiac:
Standard Elec. Co.
Saginaw:
Schmerheim Elec. Co.
Standard Elec. Sup. Co.
MINNESOTA
Duluth:
Northern Elec. Sup. Co.
Minneapolis:
Charles A. Anderson & Co.
Northland Elec. Sup. Co.
St. Paul:
Lee Elec. Co.
MISSOURI
Kansas City:
Glasco Elec.
St. Louis:
M. K. Clark
MONTANA
Great Falls:
Glacier State Elec.
NEBRASKA
Lincoln:
White Elec.
Omaha:
Electric Fix. & Sup. Co.
NEVADA
Reno:
Western Elec. Distr. Co.
NEW HAMPSHIRE
Portsmouth:
Mass. Gas & Elec. Light Co.
NEW JERSEY
Atlantic City:
Franklin Elec. Sup. Co.
Cherry Hill:
Delaware Township:
Flynn's Camden Elec. Fix. Co.
NEW MEXICO
Albuquerque:
The Lighting and Main. Co.
NEW YORK
Binghamton:
Frank Elec. Sup. Co.
Buffalo:
Buffalo Incand. Light Co. Inc.
Niagara Falls:
Nyson Supplies Inc.

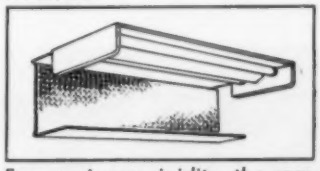
NEW YORK (cont.)
Poughkeepsie:
Electra Sup. Co.
Rochester:
Rowe Electric Sup. Co.
Syracuse:
Superior Elec. Corp.
NORTH CAROLINA
Charlotte:
Independent Elec. Sup. Co.
Durham:
Noland Co.
Greensboro:
Elec. Sup. & Equip. Co.
Kinston:
Kinston Elec.
Winston Salem:
Noland Co.
NORTH DAKOTA
Fargo:
Northwest Elec. Sup. Inc.
OHIO
Akron:
The Sacks Elec. Sup. Co.
Canton:
Electric Sales Co.
Cincinnati:
B. & B. Elec. Co.
F. D. Lawrence Electric Co.
Richards Elec. Sup. Co.
Cleveland:
The H. Leff Electric Co.
Midland Elec. Co.
Columbus:
Elgee Elec. Co.
The Lamb Elec. Co.
Elyria:
Duellman Elec. Co.
Springfield:
The W. M. Elec. Co.
Toledo:
Gross Elec. Fix. Co.
Youngstown:
Mart Industries
OKLAHOMA
Oklahoma City:
Elec. Sup. of Oklahoma
OREGON
Portland:
Baker-Barkon Co.
Malloy Robinson Co.
PENNSYLVANIA
Allentown:
Coleman Elec. Co.
Erie:
Kraus Elec. Co.
Harrisburg:
Fluorescent Sup. Co.
Hazleton:
Power Elec. Co. Inc.
Kingston:
Anthracite Elec.
New Castle:
Midwestern Elec. Co.
Philadelphia:
Ace Lighting Fix. Co.
Gold Seal Elec. Sup. Co.
Sylvan Elec. Fix. Co.
Pittsburgh:
Allied Elec. Sup. Co.
Argo Lite Studios
Scranton:
Lewis & Reif, Inc.
Uniontown:
Pioneer Electric Dist.
RHODE ISLAND
Pawtucket:
Major Elec. Sup. Co.
Providence:
Leavitt Colson Co.
SOUTH CAROLINA
Columbia:
Capitol Elec. Sup.
Noland Co.
Greenville:
Sullivan Hdwe. Co.
SOUTH DAKOTA
Watertown:
J. H. Larson Elec. Co.
TENNESSEE
Nashville:
Nashville Elec. Sup. Co.
TEXAS
Austin:
Southern Electric Sup. Co.
Dallas:
Rogers Elec. Sup. Co.
Ft. Worth:
Anderson Fixture Co.
Houston:
Gross Electric Supply
Martin Associates
Southern Electric Supply Co.
Lubbock:
Homer C. Massey & Co.
San Antonio:
Southern Equip. Co.
Strauss-Frank Co.
UTAH
Salt Lake City:
Artistic Lighting
VIRGINIA
Arlington:
Dominion Elec. Sup. Co. Inc.
Noland Co.
Lynchburg:
Mid-State Elec. Sup. Co., Inc.
Norfolk:
Noland Co.
Roanoke:
Noland Co.
WEST VIRGINIA
Huntington:
West Virginia Elec. Co.
Wheeling:
The Front Co.
WISCONSIN
Appleton:
Rice Northern Co.
Eau Claire:
W. H. Hobbs Sup. Co.
Milwaukee:
Standard Elec. Sup.
WASHINGTON
Seattle:
Seattle Lighting Fix. Co.
ALASKA
Anchorage:
Northern Supply Co.
CANADA
Montreal:
L. D. G. Products, Inc.
The Gray Elec. Co.
Union Electric Sup. Ltd.
Quebec City
La Cie Martineau Electric Co.
Toronto:
Rayora Elec. Dist.
Toronto Ltg. Studios
HAWAII
Honolulu:
Hawaiian Light & Sup. Co.

The specification: *PRISMALUX by LIGHTOLIER*

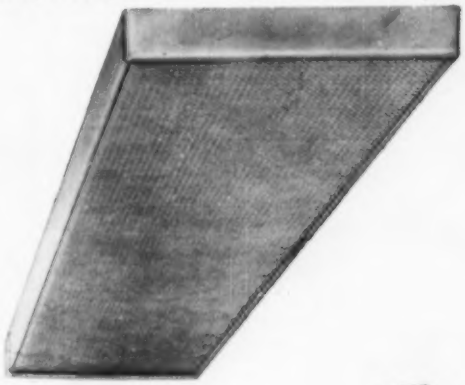
NEW—one-piece lens-and-diffuser with low brightness bottom and luminous diffuser sides to provide glare-free illumination and minimum brightness contrast. Coupled with styling that is crisp and clean, construction that is rugged and trouble free—Prismalux is an excellent specification for stores, offices, schools and other critical lighting applications. In two, three and four light widths, four and eight foot lengths, surface or stem mounted.



The fine-textured prismatic lens floods low-brightness illumination downward. The low-brightness diffuser sides send soft light out across ceilings, reduce brightness contrasts.



For maximum rigidity, the combination lens-diffuser is supported along its full length. Safety hinges permit access from either side of lens diffuser, cannot be accidentally dislodged.



To learn more about Prismalux by Lightolier, write today for a complete brochure to Dept. IE-109.

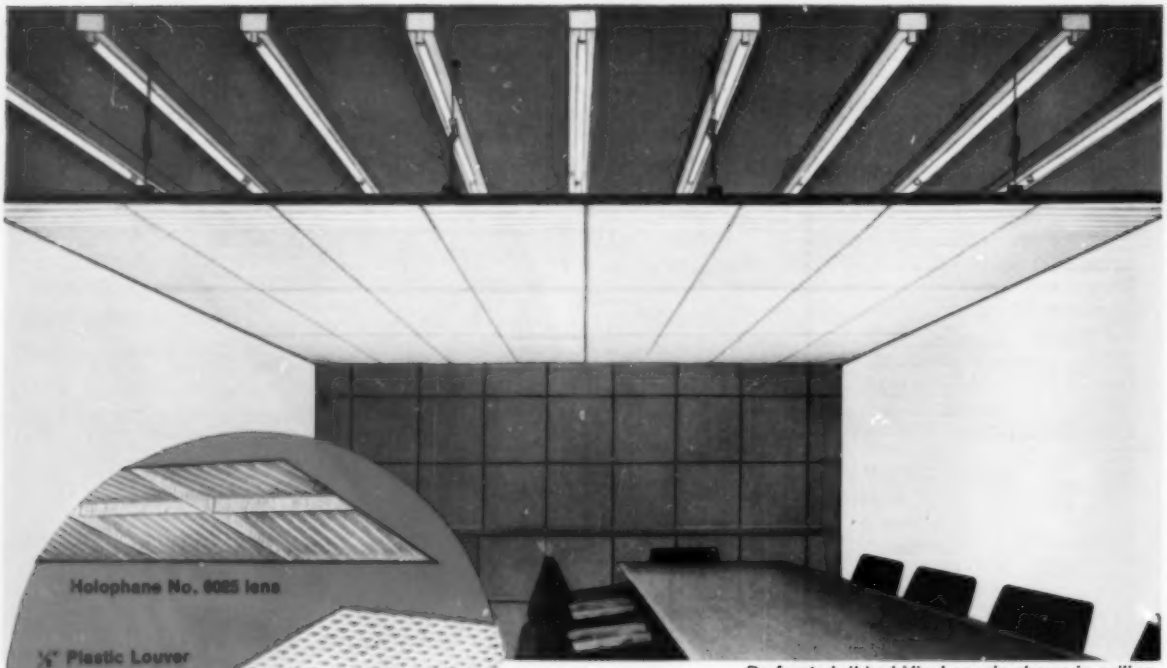
LIGHTOLIER

Jersey City 5, New Jersey

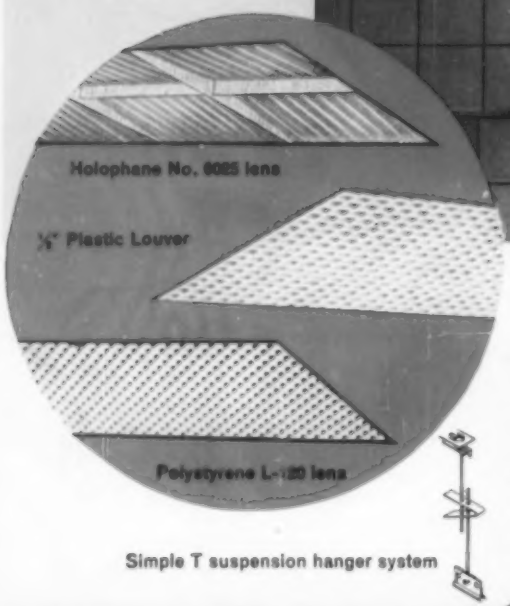
Showrooms: New York, Chicago, Dallas, Los Angeles

NOW from BENJAMIN
NEW Sky-Glo line
of illuminated plastic ceilings

- ✓ SIMPLIFIED SUSPENSION FROM LIGHTING UNITS
- ✓ LOW SURFACE BRIGHTNESS
- ✓ LATEST DESIGN PLASTIC PANELS
- ✓ SHADOW FREE WALL TO WALL LIGHTING



Perforated ribbed Vinyl panels shown in ceiling



Simple T suspension hanger system

Sky-Glo, the ultimate in modern ceiling illumination. Easily installed 2′ x 4′ panels fit any room, providing shadow-free wall to wall illumination.

Ceiling grid of lightweight aluminum alloy, rigidly fastened with easy to use lock-tabs. Simplified spring steel leveling device quickly adjusts hanger length. A wide range of closures offers complete flexibility of ceiling type. *Priced by the square foot, complete with choice of Rapid-Start, Slimline, High Output or Power-Groove lamps.*

For fixture engineering at its finest, look to Benjamin. Your local Benjamin representative will be happy to help you. Contact him on any problem...large or small.

BENJAMIN

ELECTRIC MFG. CO., Des Plaines, Illinois

Subsidiary of THOMAS INDUSTRIES INC

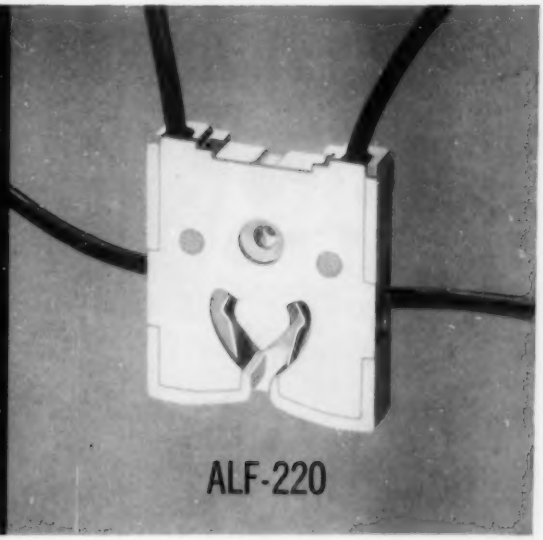
BENJAMIN · MOE LIGHT · STAR LIGHT · ENCHANTE · SAN MARINO

NOW! You can wire and mount fluorescent lampholders faster, at lower cost than ever before!

General Electric announces

NEW THIN PRESSURE-LOCK LAMPHOLDER

for medium bi-pin lamps



Here are the time-and-money saving benefits that make this new General Electric lampholder the biggest thing in years for manufacturers of fluorescent lamp fixtures:

- **Faster, easier wiring!** Exclusive General Electric pressure-lock termination allows simple insertion of tinned leads; spring holds them in place firmly. Result: faster wiring that cuts assembly.
- **Double connection for each contact!** Permits top or side wiring or jumper connection for rapid start circuits.
- **Easy removal of wires**—when you want—is provided by wire release slots built in at each connection.
- **Fast single-screw mounting!** Lampholder mounts with one #6 screw. Anti-rotation slot and bosses provided on back and top of lampholder.
- **Minimum back-to-back dimension!** This new design provides for 47 15/16" mounting for 48" modular fixture length.
- **Ideal for modern fixture design!** The combined features of size, wiring connections and mounting make this lampholder unsurpassed in versatility. Standardizing on this lampholder will simplify your stocking and ordering problems.

Free sample and descriptive literature will show you in greater detail how General Electric's new pressure-lock lampholder can help you to lower-cost wiring and mounting. Rating: 660 watts, 600 volts, UL Approved. Mail coupon today!

Progress Is Our Most Important Product

GENERAL ELECTRIC

Marketing Section, Accessory Equipment Dept.
General Electric Co., 1285 Boston Ave.
Bridgeport 2, Conn.

Please send me free sample and descriptive literature on new G-E pressure-lock lampholders.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

HOW CBM ASSURES YOU BETTER BALLAST VALUE

ETL checks 12 to 14 specified ballast characteristics on all Certified types in production by each manufacturer, verifies compliance by test . . . and does it every month!

SPECIFIED performance is checked by test . . . that's why you can always rely on Certified CBM ballasts for dependable lighting service.

What characteristics are checked? The operating qualities which the American Standards Association has determined will give dependable, rated performance from the lamps with which the ballasts are designed to be used. These constitute the CBM Specification and assure:

High power factor • High light output • Positive starting • Rated lamp life • Limit on heat rise • Control for steady light • Quiet operation

From these qualities come practical benefits: Up to 2,500 hours more lamp life than with ordinary ballasts; as much as 40% more light output; and savings on installation . . . with less wire, fewer circuits needed for fixtures CBM equipped . . . fewer fixtures for the same level of light.

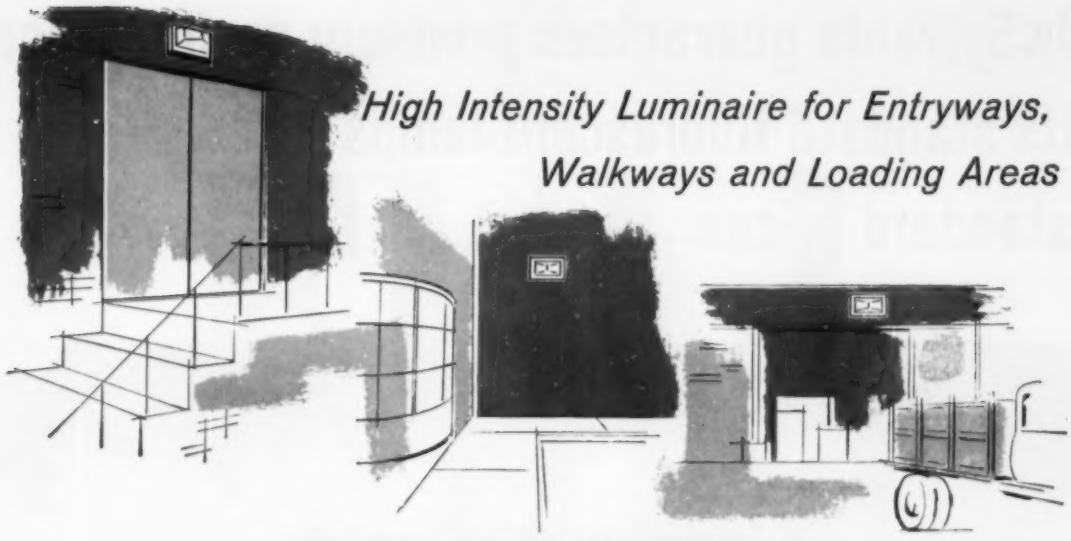
For the latest facts on why it pays to specify fixtures equipped with Certified CBM Ballasts, ask us to send you CBM NEWS.

CBM CERTIFIED by ETL

CERTIFIED BALLAST MANUFACTURERS

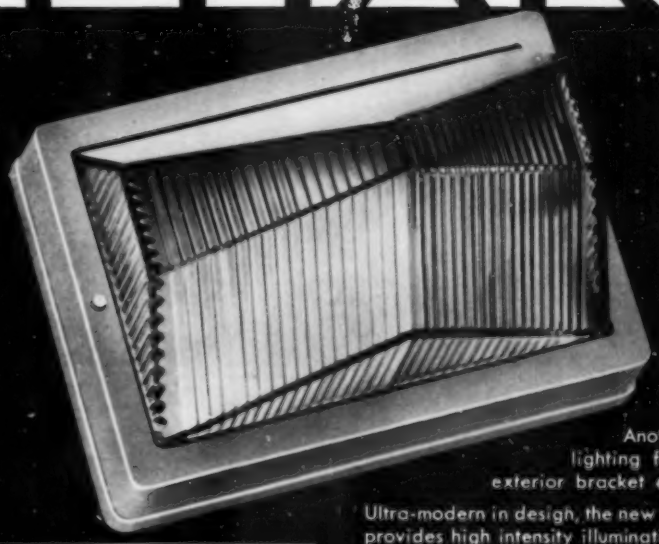
2112 KEITH BUILDING
CLEVELAND 15, OHIO

Participation in CBM is open to any manufacturer who wishes to qualify



High Intensity Luminaire for Entryways, Walkways and Loading Areas

The PERFECLITE "PHAROS"



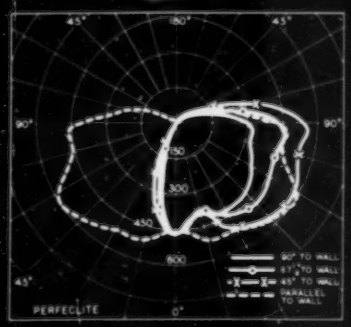
A Totally New Concept In Controlled Exterior Illumination

Another first from Perfeclite! A modular shaped lighting fixture that completely outmodes the usual exterior bracket extending on a heavy arm from the wall.

Ultra-modern in design, the new Pharos gives an asymmetric light pattern . . . provides high intensity illumination for wall areas . . . disperses a powerful outward distribution of light 90° from the wall as well. The heat-resistant glass refractor uses accurately calculated prisms on seven transmission surfaces . . . incorporates a silvered glass reflector at the top which directs the light downward.

Made of cast aluminum, gasketed and weatherproofed, the Pharos opens on concealed hinges for easy relamping, easy maintenance. It is rated at 200 watts, utilizing a standard A-25 lamp.

For further information, mail the attached coupon today!



CANDLEPOWER DISTRIBUTION
200 W. A-25 I. F. LAMP
E. T. L. REPORT NO. 372483
Units are Underwriters' Laboratories Inc. approved.

THE PERFECLITE COMPANY
1457 East 40th Street Cleveland 3, Ohio

Please send me the Perfeclite Data Folder 59-C.

NAME _____

ADDRESS _____

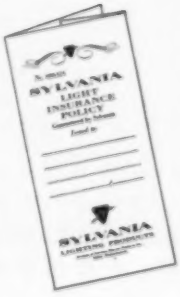
CITY _____ STATE _____

Only Sylvania guarantees premium performance in its standard fluorescent lamps at standard prices—*with an exclusive Light Insurance Policy!*

Sylvania Fluorescent lamps are made to *one* standard of quality only—the highest. And you get it at standard prices.

Conduct your own light meter test. Take for instance, Sylvania's 40-watt Cool White Rapid Start Lamps and any similar competitive lamp claiming extra lumens. Operate them for a few weeks. Keep a record of their performance.

You'll prove to yourself Sylvania standard fluorescents deliver more light, cost less. And if you care to measure lumens output during lamp life, you'll find Sylvania lamps burn brighter and longer.



That's why Sylvania backs up its statements with an exclusive money-back guarantee! Sylvania Fluorescents must give you more light at lower cost than any other brand—or cost you nothing!

Interested in learning more? Ask your Sylvania representative or supplier to see a copy of this revolutionary Sylvania Light Insurance Policy. Or write:

SYLVANIA LIGHTING PRODUCTS
Dept. 9L-3510, 60 Boston Street
Salem, Mass.
In Canada: Sylvania Electric (Canada) Ltd.
P. O. Box 1190, Station "O", Montreal 9

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

FULL LIGHT OUTPUT

Sola ballasts guard your reputation by giving full-rated lumen output

When you install, furnish, or specify Sola fluorescent ballasts, you're confident that this line of all-CBM-certified ballasts delivers the total light output demanded by CBM performance standards. Conservatively engineered to surpass CBM specifications, Sola ballasts boast hefty reserve tolerances both in materials and components.

Sola-ballasted lamps and fixtures live up to their output ratings and give cool, efficient, trouble-free service. They satisfy the engineer, the fixture manufacturer, the contractor, and — most important — the man who insists on all the light he's paying for. Sola ballasts guard your reputation. Why not call your district sales engineer now and get all the facts. ***Sola Electric Co.*** (A Division of Basic Products Corporation) ***4633 W. 16th Street, Chicago 50, Illinois.***

SOLA BALLASTS

lighting
design
by
mc Philben

45W wall mounted edge-lit

45R recessed
ceiling mounted edge-lit

cast aluminum
quality

mc Philben's 45 line edge-lit directionals are designed to blend with the finest contemporary decor in hotel lobbies, auditoriums, office buildings, schools and other public locations.

Gleaming satin finish . . . solid cast aluminum construction . . . wall, ceiling or surface mountings . . . incandescent and fluorescent models . . . invisibly hinged access doors . . . flush fasteners . . . acrylic-Plexiglass inscription panels illuminating full length of letter . . . these are some of the features making mc Philben's 45 line edge-lit directionals the architect's first choice for use in the nation's finest buildings.

The 45 line series is available with either "exit" or special wording inscriptions. 4½", 6" or 8" lettering with red, green and white color combinations conform with all local regulations.

Contact your mc Philben representative today for full details. See our insert in Sweet's file 17 or write for data sheet E-1.

mc Philben
LIGHTING COMPANY
1329 Willoughby Avenue
Brooklyn 37, New York

(*Continued from page* 15A)

of the National Academy of Sciences, with which the National Research Council is affiliated, made the appointment.

Arrangements have recently been concluded by **J. L. Jaffe, Jr.**, President, Perfeclite Co., Cleveland, Ohio and **W. L. Vincent,** Vice-President in charge of sales, Electrolier Manufacturing Co., Ltd., Montreal, Que., for the fabrication and sale of Perfeclite products by Electrolier, throughout Canada. Under the terms of the agreement, Electrolier will be the exclusive Canadian producer of Perfeclite fixtures and all sales will be handled through their recognized distributors.

Howard Long, for many years IES's most active overseas member, has recently established a consulting engineer and lighting specialist office at 58 Georges Wood Road, Hatfield, Herts, England. He will continue his activities with several IES (American) committees, on which he has served with distinction for many years.

Duro-Test Corp., North Bergen, N. J. has announced the elections of **G. Melville Tuppen** as vice-president in charge of sales and **G. Raymond McGruther** as vice-president in charge of sales administration. Mr. Tuppen, Little Rock, Ark., joined the company in 1930 as a sales representative; Mr. McGruther, Allwood, N. J. has been with Duro-Test since 1947.

John B. O'Donnell has been named to the newly-created position of distributor sales manager for Sola Electric Co., Chicago, Ill. Mr. O'Donnell has been with Sola for 19 years, most recently as New England district sales manager.

Lighting Dynamics, Whittier, Calif., has announced the promotion of **John Sankewich** from Northern California regional sales manager to sales manager of the Western Division, with offices at the company's Whittier plant. Succeeding Mr. Sankewich as Northern California sales manager is **Dave Parker.** Mr. Parker will have his offices at 1485 Bayshore Blvd., San Francisco.

Gordon Wells, general sales manager of Day-Brite Lighting, Inc., St. Louis, Mo., has announced the appointment of **John Gornet** as manager of the firm's newly-established Custom Design Department. The appointment was effective August 17. Mr. Gornet has been with Day-Brite for 23 years, originally as head of the Engineering Department; most recently as manager of new products. Also announced by Mr. Wells was the appointment of **Raymond P. Imre** as manager of sales for the Midwestern Region, encompassing 11 states extending from Minnesota to Texas and from Missouri to Colorado. He will have his offices at the company's Marketing Division in St. Louis. Prior to this appointment, Mr. Imre was executive vice-president of Charles B. Ferris Associates, Architects and Engineers.

J. Horton Fall, III, formerly with the Benjamin Electric Manufacturing Co., Des Plaines, Ill., has recently become associated with F. S. Moseley & Co., Chicago brokerage firm.

Election of **Richard A. Daunoras** to the position of treasurer has been announced by Advance Transformer Co., Chicago. Prior to this appointment, Mr. Daunoras had been the controller of the company.

Jack Benatan has been advanced to the position of regional sales manager for Jewel Electric Products, Inc., with offices in Pittsburgh, Pa. Mr. Benatan was previously located in Harrisburg, Pa. as the firm's division sales manager.

Effective September 1, **Walter P. Cartun** was named general manager of the General Electric Co. Miniature Lamp Department, with offices at Nela Park, Cleveland. Prior to this appointment, Mr. Cartun was manager of the firm's lamp equipment operation, also in Cleveland. In assuming the new position, Mr. Cartun succeeds **Kenneth G. Reider** who retired after 42 years of service to G-E. Mr. Reider will remain with the department as a consultant.

Ray M. Taylor has been appointed manager of purchases for Southern California Edison Co., succeeding **C. F. Ahland** who died on August 15. Mr. Taylor joined the company's commercial department in 1922 and has served successively as supervisor of sales, chief buyer and assistant manager of purchases. He had been in the latter position since 1949.

Richard H. Arbib Co., Inc., New York City product design firm, has been retained by Silvray Lighting Inc., Bound Brook, N. J., to develop new ideas for products in Silvray's recently organized consumer division.

Metalcraft Products Co., Inc., Philadelphia fixture manufacturer, has announced the appointment of **P. R. Blackburn** as sales manager for its Metco

(*Continued on page* 48A)

RLM Quality Fixtures

made by these MANUFACTURERS

are now **MORE IMPORTANT** than ever!

YES! The new, much higher Industrial Lighting levels now recommended by I.E.S.* make QUALITY more important than ever!

Q *Why is reliance on fixtures with the RLM LABEL more important than ever?*

A *Because RLM TECHNICAL COMMITTEES have* for many years recognized the need for higher footcandles in industrial lighting and have been continuously revising upward the RLM Specifications for existing equipment and developing new specifications for new types of units. RLM Labeled units are ready to meet the task of re-lighting Industrial America to the new higher I.E.S.* recommendations.

Q *How can I BEST OBTAIN information on RLM Specifications and I.E.S. Recommendations?*

A *By mailing the COUPON TODAY.*

Be sure to check all items on which you desire information.

**The Illuminating Engineering Society is a non-profit organization of illuminating engineers and others interested in the advancement of the science of illumination.*

INCANDESCENT RLM SPECIFICATIONS								FLUORESCENT RLM SPECIFICATIONS									
								0-30% UPLIGHT					20-30% UPLIGHT				
#1	#2	#3	#4	#10	#40	#41		D-1	D-1	D-1	D-2	D-2	D-3	SD-1	SD-1	SD-1	
3	3	1	3		3		ABOLITE										
4	3	2		1			APPLETON										
3	4	4		1			BENJAMIN	✓	✓	✓	✓	✓	✓	✓	✓	✓	
							CURTIS-ALLBRITE LTD.	✓	✓	✓	✓	✓	✓		✓	✓	✓
4	4						ELECTRO	✓	✓	✓	✓			✓	✓	✓	✓
							ENDER-MONARCH	✓	✓		✓						
							GUTH	✓	✓	✓	✓	✓	✓		✓	✓	✓
							KEYSTONE	✓	✓		✓	✓			✓	✓	
							LIGHTING DYNAMICS	✓	✓		✓	✓			✓	✓	
4			2				MILLER										
4				1			MULTI	✓									
4	4	3					OVERBAGH & AYRES										
6	4	6	3	2			QUADRANGLE										
							RUBY-PHILITE	✓	✓	✓	✓	✓			✓		
							SMITHCRAFT	✓	✓	✓	✓	✓			✓	✓	✓
3	3	3					SMOOT-HOLMAN	✓	✓	✓	✓	✓	✓		✓	✓	✓
4	1		1				SPERO										
5		2	2		4	2	STEBER										
							SUNBEAM	✓	✓	✓	✓	✓	✓		✓	✓	✓
							SYLVANIA	✓			✓			✓	✓	✓	✓
4	1	1			1		WAKEFIELD	✓	✓	✓							
5	4	3		3			WESTINGHOUSE	✓	✓	✓	✓	✓	✓		✓	✓	✓
5	4	1					WHEELER-FULLERTON	✓	✓	✓	✓	✓	✓	✓	✓	✓	
							WORK-O-LITE	✓	✓	✓	✓	✓	✓				

*Aluminum Reflectors all others are Porcelain Enamel

NOTE: Many manufacturers make incandescent RLM Units for more than one lamp size. The numerals refer to the number of different size RLM Units which the manufacturer offers under the specification.

This label identifies the RLM certified lighting equipment of 24 leading manufacturers.

CHECK ITEMS AND MAIL TODAY:

RLM STANDARDS INSTITUTE, INC.
326 W. Madison St., Suite 8230, Chicago 6, Illinois

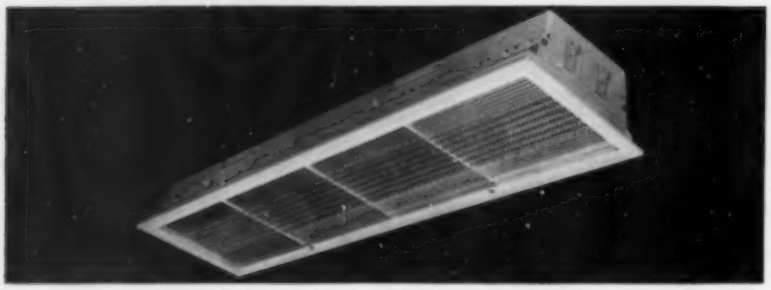
Send me free of cost or obligation:

- ☐ NEW 1959 RLM SPECIFICATIONS BOOK containing latest RLM Specifications.
- ☐ New I.E.S. higher footcandle RECOMMENDATIONS.

Write name, company and address in margin or attach this coupon to your letterhead.

RLM STANDARDS INSTITUTE

EXCLUSIVE

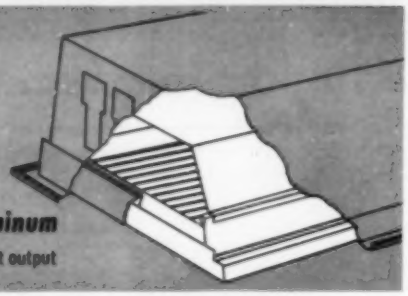


only **aurora**

RECESSED TROFFERS

give you this built-in
"light trap" of extruded aluminum

Seals troffer interior, increases useable light output



EXCLUSIVE

only **aurora**

gives you this extruded aluminum slide-in frame for glass and plastic diffusers

Tapered for hairline fit, lightproof closure

EXCLUSIVE

only **aurora** *gives you this total combination for better troffer lighting*

- ★ All exposed surfaces of aluminum
- ★ Adapts to any ceiling
- ★ All sizes to 4 x 4, including new 18"-wide series
- ★ Choice of 19 shieldings including Holophane lenses*
- ★ Modular dimensions . . . fast, easy installation
- ★ Flexible lamp arrangements
- ★ Circu-vent design for heat dissipation

Get the complete AURORA story . . . write today for our new Bulletin T-759.

*authorized Holophane distributor

metco Lighting

SOLD ONLY THROUGH QUALIFIED ELECTRICAL DISTRIBUTORS

METALCRAFT PRODUCTS CO., INC., 6225 State Road, Phila. 35, Pa.

(Continued from page 46A)

Lighting line. For the past eight years, Mr. Blackburn had been Middle Atlantic States district manager for Westinghouse Electric Supply Co. In his new connection, Mr. Blackburn's headquarters will be at Metalcraft's new plant and main offices in Philadelphia.

Prescolite Manufacturing Corp., Berkeley, Calif., has announced the appointments of **Glenn G. Gulvin** as Eastern sales and service representative and **William Govan** as sales order manager for the 11 Western states. Mr. Gulvin will be located at the company's Eastern headquarters in Neshaminy, Pa.; Mr. Govan will have his office at the main plant in Berkeley.

Union Metal Manufacturing Co., Canton, Ohio, has announced the opening of a new West Central District office with **James S. Boggs** as branch manager. Headquarters for the new district, which includes Kansas, Nebraska, Iowa and Missouri, will be at Kansas City, Kans. Mr. Boggs will handle the sales of all Union Metal products. **A. W. Crary,** the company's sales representative at Kansas City, will continue to handle street lighting sales in Kansas and Western Missouri.

In connection with the expansion of its West Coast facilities, Monsanto Chemical Co., St. Louis, Mo., has announced the following appointments. **David M. Williamson,** assistant director of manufacturing for the company's Plastics Division since 1955, has been named to the newly created position of director of manufacturing for the West Coast. **Roland H. Dunlop** has been promoted from manufacturing superintendent of the Santa Clara, Calif., plant to plant manager, a position previously held by Mr. Williamson, in addition to his other duties. **John F. Fincke** will be assistant director of research for the Plastics Division and in charge of the laboratories at Santa Clara. Mr. Fincke had been a research section leader since 1954.

The Illuminating Engineering Society of Great Britain has announced that His Royal Highness, **Prince Philip, The Duke of Edinburgh,** has expressed his interest in the work being done by the Society and has accepted the invitation to become its first Honorary Fellow. This event has taken place during the Golden Jubilee year of the British IES.

Kenneth D. Jensen has been named vice-president in charge of sales for Luxor Lighting Products, New York. Mr. Jensen had previously served as

(Continued on page 50A)

AGAIN UNION METAL LEADS IN NEW POLE ENGINEERING- FOR TODAY'S LUMINAIRES

Announcing

BULLETINS LS-29 AND LS-30 featuring steel and aluminum poles properly engineered to meet today's rigid roadway requirements.

Monotube poles have the required "built-in" qualities for supporting the latest in filament, mercury and fluorescent luminaires.

Monotube Engineered Poles

THE UNION METAL MANUFACTURING CO.
CANTON 5, OHIO • BRAMPTON, ONTARIO

For the first time, distinctive styling and beauty have been combined with durable WEATHERPROOF die-cast aluminum construction to produce an engineered outdoor lighting fixture with all the elegance of an indoor fixture.

Moldcast die-cast aluminum Bullets make it unnecessary to use indoor, fragile, non-weatherproof fixtures outdoors. Moldcast Bullets are a superb "wedding" of the best advantages of indoor decor with outdoor ruggedness in a wide range of outdoor finishes which are impervious to the elements. (Amazing Luster Light Finish recently passed a 1000 hour salt spray test with "flying colors").

Moldcast fixtures are designed to fully enclose the sealed beam spot and reflector lamps, thus eliminating the back halo of light seen with exposed lamps, and directing the beam with maximum intensity where it is desired.

Ideal for every outdoor application: schools, hotels, motels, building fronts, signs, around the home, swimming pool, etc.

Contact Moldcast for complete catalog of the entire line covering fixtures for all sealed beam lamps, including specifications, light curves, applications and prices.

AVAILABLE NATIONALLY THROUGH LEADING ELECTRICAL DISTRIBUTORS. NATIONAL REPRESENTATION

Originators of Cast Aluminum Bullets for Outdoor Use

MOLDCAST manufacturing company

236 South St., Newark 2, N. J.

(Continued from page 48A)

western division manager for the company, with headquarters in San Mateo, Calif., and during the past year has been general sales manager, with offices in New York.

Austin Electronics, a Division of the Austin Co., succeeded the Special Devices Division of the company, according to a recent announcement. The change in name for the automation and electronic research and development firm was effective September 15, 1959. **Alexander H. Kuhnel,** manager of the Special Devices Division for the past year, will manage the new Division. The company's headquarters will remain in New York City.

Joseph C. Lowey, general manager of sales for Clayton Mark & Co., Evanston, Ill., has been appointed speakers bureau chairman of the Conduit Section of the National Electrical Manufacturers Association, according to a recent announcement by **H. R. Coward,** chairman of the rigid steel and E.M.T. conduit section of the Association.

A. O. Grotenhuis, Southern Pacific Division sales manager, Moe Light Division of Thomas Industries, has been named to the Guidance Committee of the Business Development Section of the Pacific Coast Electrical Association, Inc. Mr. Grotenhuis will serve as vice-chairman of the Association's Residential Lighting Committee.

The signing of **Joseph Fishman** as special sales representative for New England has been announced by The Universal Manufacturing Corp., Paterson, N. J. Mr. Fishman was previously a vice-president of the Smitheraft Corp., Chelsea, Mass. **Jules Schwartz** will continue in his present capacity as district manager for New England and Canada.

Biscayne Electric Supply Co. and **Spolter** Electric Supply Co., both of Miami, Fla., have been named by Sylvania Lighting Products, division of Sylvania Electric Products, Inc., as lamp distributors in the greater Miami area.

The **Robert M. Langmack** Co., Los Angeles, Calif., has been named as West Coast sales representative for the aluminum lighting standards department of Read Standard, York, Pa., a division of Capitol Products Corp.

Deaths

William H. Heim, Eastern Pennsylvania Section.

C. C. Munroe, Jr., Michigan Section.

Edward J. White, New Jersey Section.

Philip P. Wienick, Chicago Section.

EMPLOYMENT OPPORTUNITIES

NEW YORK CITY REPRESENTATIVE AVAILABLE

Interested in representing a well-established manufacturer of fluorescent and/or incandescent lighting fixtures. Seven-year following of architects, engineers, contractors and wholesalers. Address Box 404, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

POSITION WANTED

Graduate Electrical Engineer desires responsible position in Canada in a senior engineering or administrative capacity in the lighting industry. Over 20 years' experience in the lighting field. Full particulars of qualifications and experience will be supplied on request. Address Box 409, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

SALES ENGINEER WANTED NEW YORK CITY

Major manufacturer of commercial and institutional lighting equipment, located in New York City, seeks experienced salesman to call on architects and engineers. Should be familiar with contractors and distributors in the metropolitan area. Excellent opportunity for competent, aggressive individual with long established, well equipped company. Replies in strict confidence. Address Box 410, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

CUSTOM CHANDELIER DESIGNER

Excellent opportunity with prominent New York fixture manufacturer for experienced, capable designer of custom chandeliers. Must be able to create original designs and translate them into detailed shop drawings. Experience in price estimating and thorough knowledge of fabricating processes essential. Send details in strictest confidence to Box 411, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

MANUFACTURER'S REPRESENTATIVE WANTED

Lighting fixture manufacturer's representative wanted for the states of Arkansas, Northern Mississippi, Tennessee, Michigan, New England States (not including Connecticut), and St. Louis, Missouri. Exceptional opportunity for experienced lighting salesman to represent a national company. Manufacturing complete lines of RLM approved reflectors, high bays, floodlights, vaportight fixtures, PAR lampholders and secondary racks. Address Box 412, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

REPRESENTATIVE WANTED

Sales representative or sales organization wanted to contact Architects, Engineers and Electrical Distributors and sell nationally known patented Integrated and Translucent Ceiling line. Unlimited potential. Many new (protected) sales territories are open. Complete catalog. Progressive Sales Promotion Program. Contact our agent: T. R. Lufrano & Assoc., 6 Doris Place, Berkeley 5, Calif.

POSITION AVAILABLE

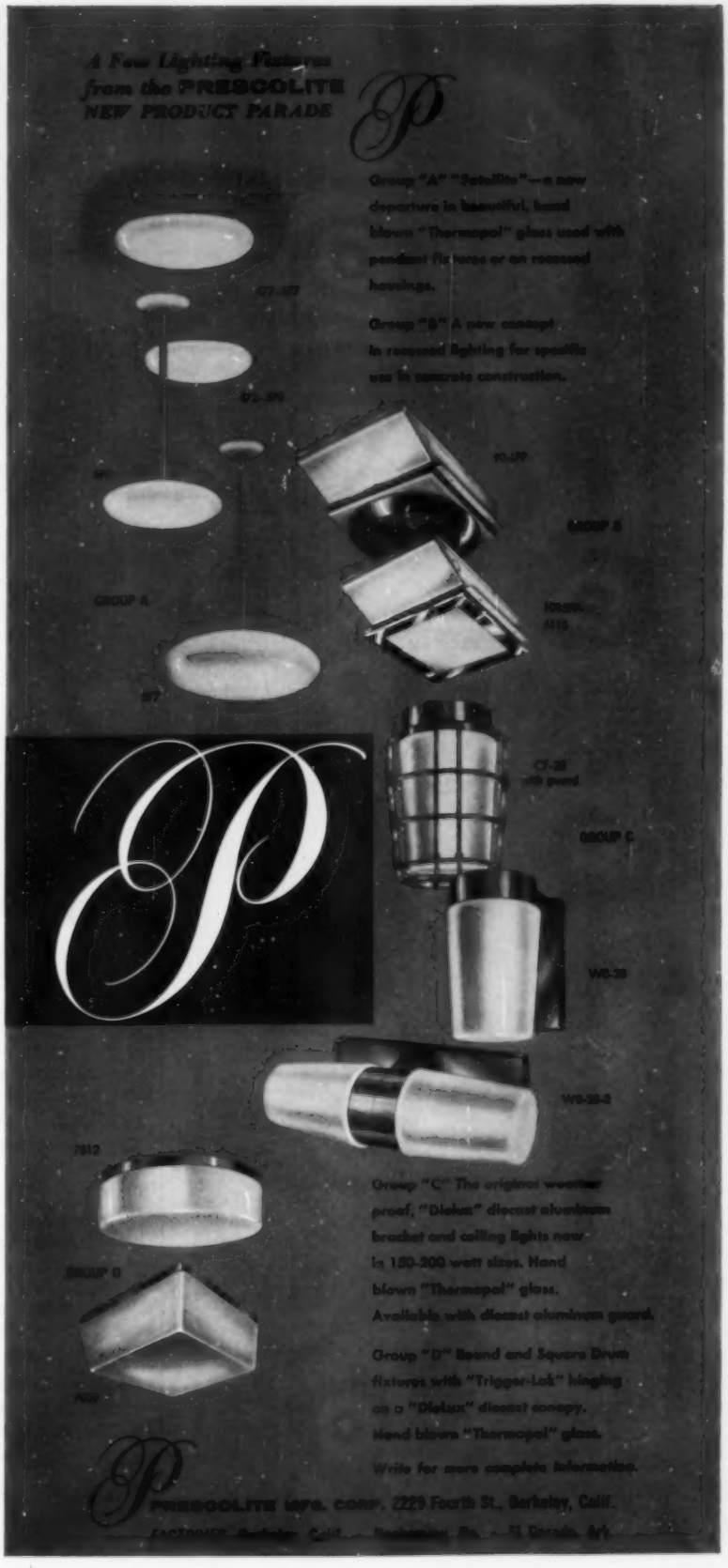
Experienced Commercial Lighting Specialist to manage Commercial and Industrial lighting department for large Electrical Wholesaler in Southern Connecticut. Address Box 413, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

OPPORTUNITY

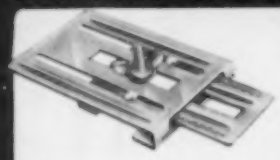
Young man with lighting engineering or interior design or architectural background to be trained as SALES ENGINEER and Design Assistant, some traveling required (salary and commission); wanted by internationally known lighting concern. Apply to Box 414, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

INDEX TO ADVERTISERS
October 1959

Advance Transformer Co.	1A
Appleton Electric Co.	36A
Benjamin Electric Mfg. Co., Subsidiary of Thomas Industries Inc.	40A
Certified Ballast Manufacturers	42A
Columbia Electric & Mfg. Co.	10A-11A
Corning Glass Works	13A
Curtis-All Brite Lighting, Inc.	4A-5A
Day-Brite Lighting Inc.	32A
General Electric Co., Accessory Equipment Dept.	41A
General Electric Co., Lamp	24A
Gotham Lighting Corp.	21A
Edwin F. Guth Co.	Back Cover
Jefferson Electric Co.	35A
Kopp Glass Inc.	27A
Lighting Products Inc.	22A-23A
Lightolier	39A
Line Material Industries, Div. of McGraw-Edison Co.	29A
Litecontrol Corp.	6A
R. A. Manning Co.	52A
McPhilben Lighting Co.	46A
Metalcraft Products Co. Inc.	48A
Moldcast Mfg. Co.	50A
Monsanto Chemical Co.	18A
NL Corp.	52A
Perfeclite Co.	43A
Prescolite Mfg. Co.	51A
Revere Electric Mfg. Co.	14A
RLM Standards Institute	47A
Sola Electric Co.	45A
Smithcraft Corp.	31A
Sunbeam Lighting Co.	16A-17A
Sylvania Electric Products Inc.	2A, 41A
Union Metal Mfg. Co.	49A
Wakefield Co.	Inside Front Cover
Daniel Woodhead Co.	52A


A Few Lighting Fixtures from the PRESCOLITE NEW PRODUCT PARADE
Group "A" "Satellite"—a new departure in beautiful, hand blown "Thermopal" glass used with pendant fixtures or on recessed housings.
Group "B" A new concept in recessed lighting for specific use in concrete construction.
GROUP A
GROUP B
GROUP C
GROUP D
Group "C" The original weather proof, "Dielux" diecast aluminum bracket and ceiling lights now in 150-200 watt sizes. Hand blown "Thermopal" glass. Available with diecast aluminum guard.
Group "D" Round and Square Drum fixtures with "Trigger-Lok" hinging on a "Dielux" diecast canopy. Hand blown "Thermopal" glass.
Write for more complete information.
PRESCOLITE MFG. CORP. 2229 Fourth St., Berkeley, Calif.

New BULB-TEE Fixture Hanger



#220

#220—For Bulb-Tee, Tee Bars, other flanged structurals.

- √ Cuts Labor Costs
- √ Eliminates Holes, Drilling, Tools
- √ Speeds Installation
- √ Fully Adjustable — from 1¼" to 2¾"

New #220 hangs fixtures, metal raceways, troughs, outlet boxes, etc.—faster and easier—on bulb-tee, tee bars, and other flanged structurals. Try them on your next job!

HANG FIXTURES FASTER ON INVERTED "T" BAR ACOUSTICAL CEILING WITH

699

#210

The #210 SNAPEE Grid Hanger snaps onto "T" bar, slides into desired position and locks securely at right spot. Mount fixture in position, fasten wing nut, and the job's done.

FREE SAMPLE HANGERS Now—"Try before you buy"—right on job. Write today for free samples of 220, 210 Hangers!

DANIEL WOODHEAD COMPANY
15 N. Jefferson St., Chicago, Illinois

CHURCH Lighting Job?

Here's how **NL** *helps you!*

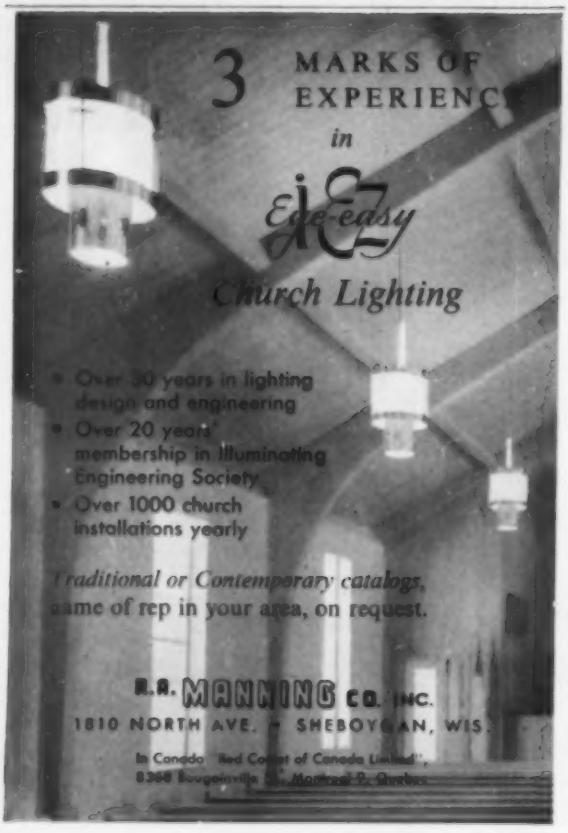
Layout service, based on half-a-century of church lighting experience, is yours for the asking.

Selection from hundreds of designs for traditional or contemporary churches.

Sales assistance from representatives throughout the country, to help you clinch the job.

Write for catalog

NL Corporation
formerly The Novelty Lighting Corporation
2490 East 22nd Street, Cleveland 15, Ohio
Designers and Manufacturers...Since 1905


3 MARKS OF EXPERIENCE
in
Eze-easy
Church Lighting
• Over 30 years in lighting design and engineering
• Over 20 years' membership in Illuminating Engineering Society
• Over 1000 church installations yearly
Traditional or Contemporary catalogs, name of rep in your area, on request.
R.A. MANNING CO. INC.
1810 NORTH AVE. • SHEBOYGAN, WIS.

More new lighting ideas . . .

I. E. S.

LIGHTING DATA SHEETS

SERIES XXIV

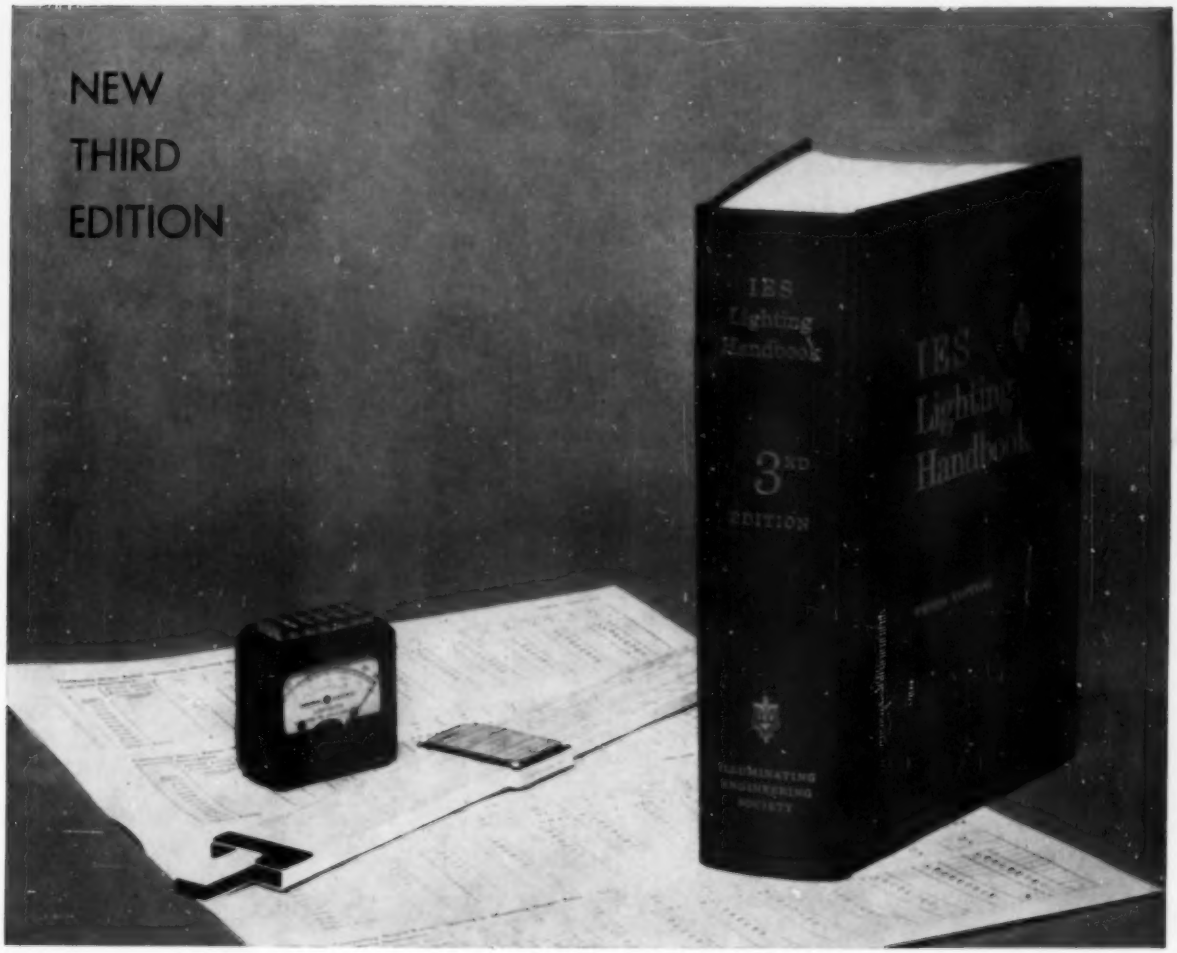
One of the greatest of lighting sales tools. Each of the 24 sheets in the Series shows all essential information for an outstanding lighting job of our time; 24 jobs of practically every description; every type of lighting. Data sheets are informative and concise . . . proven lighting-idea builders over the years.

Remember, I.E.S. Lighting Data Sheets must meet I.E.S. recommended practices to be accepted. Now . . . this means meeting new recommended lighting levels as well.

New subscriptions and renewals for regular users are being taken now for the latest Series of these well-known and widely recognized helps to selling better lighting. Total 24 sheets; first eight available immediately, balance in two lots, October and January. Full subscription, all 24 sheets, $1.25; 10 or more sets, $1 each.

Order Series XXIV for your personal file; or in quantity for your staff or customers. Write for sample data sheet.

Publications Office
ILLUMINATING ENGINEERING SOCIETY
1860 Broadway New York 23, N. Y.



I.E.S. LIGHTING HANDBOOK, New Third Edition

"A complete lighting library in one volume" is how users have described the *I.E.S. Lighting Handbook*, latest edition of which was just published in late March. Over 10,000 copies of this brand-new Third Edition are now being used by people concerned with lighting in all parts of the world.

With lighting rapidly becoming one of our most dynamic industries, these people know that they must have latest basic information of lighting techniques and applications to understand and keep abreast of new developments. In this changing situation, there is no substitute for the new Third Edition even though you may be devoted to your 1952 or even 1947 edition of the old Handbook.

Remember, there is no finer authority for your lighting recommendations and decisions than the Third Edition, *I.E.S. Lighting Handbook*, so be sure your Handbook is the latest.

PRICES

Single copy, boxed and postpaid; $10.

Registered Member Copy; one per I.E.S. member (unless previously ordered), $7.50.

Quantity prices upon request.

Use coupon to order Handbook or request descriptive brochure.

Publications Office

ILLUMINATING ENGINEERING SOCIETY

1860 Broadway **New York 23, N. Y.**

Send immediately _____ copy (ies) I.E.S. Lighting Handbook, Third Edition, to below:
(Please print)

Name _____

Address _____

_____

( ) **Send Brochure**

( ) **Check, m.o. enclosed** ( ) **Bill me**

Guth LIGHTING

PRESENTS

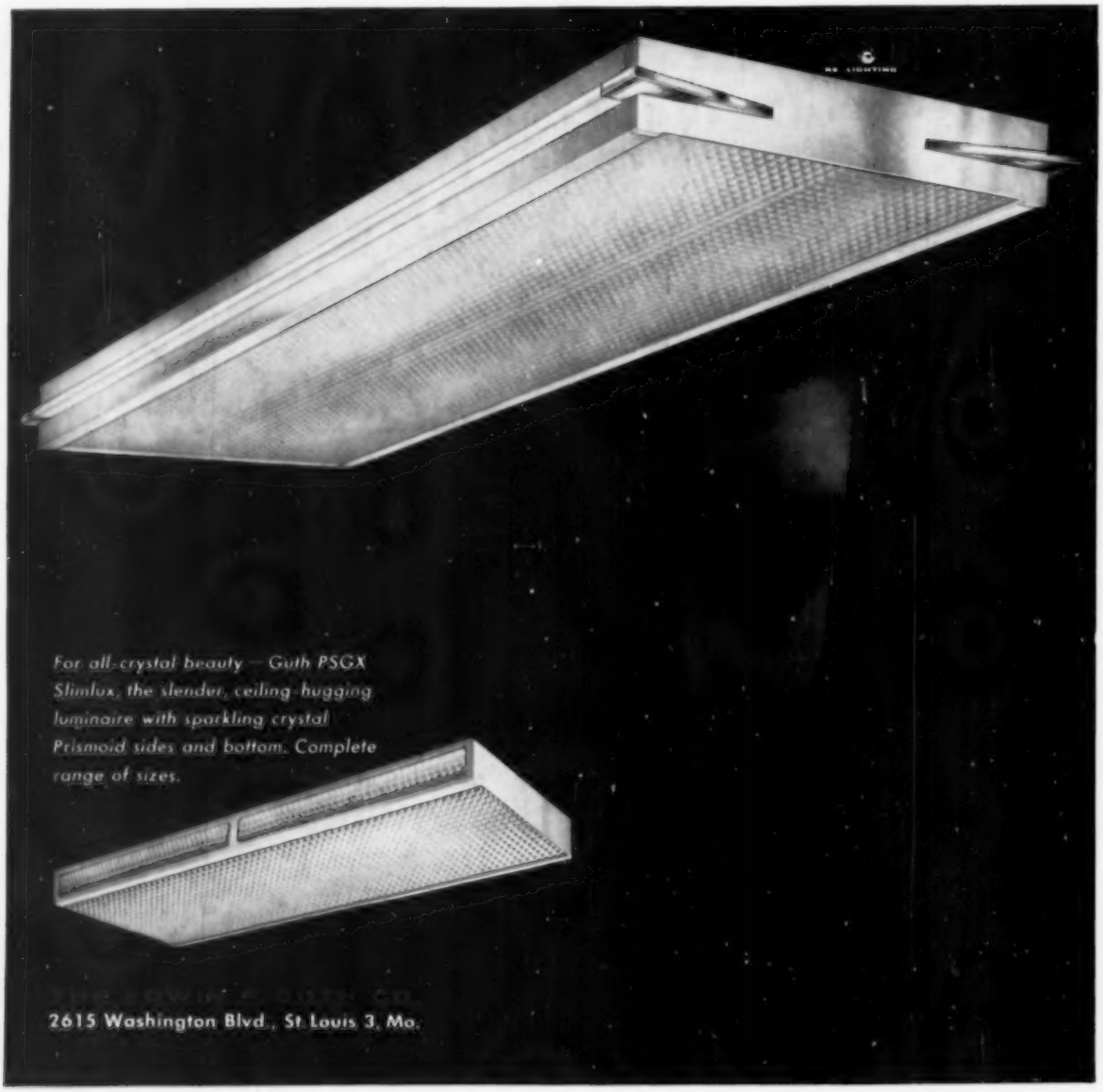
SLIMFIN

...SWEPT-WING BEAUTY
WITH MORE THAN
A TOUCH OF GLAMOR!

The high-style, eye-comfort luminaire . . . designed in the fashion of a Paris Original . . . to bring new glamor to lighting.

Polystyrene side fins emit soft beams of light to emphasize the graceful fixture lines. Color-fashioned in three beautiful finishes . . . sun drenched bronze, satin silvan or gloss white. Chrome end fins add a decorator's flair. 4′ and 8′ lengths. Two and four light widths. Choice of GrateLite, Prismoid or metal cross-baffle bottoms. Apparent depth only 1½″. The finest for slim contemporary, close-ceiling installations.

WRITE FOR FREE BROCHURE



For all-crystal beauty — Guth PSGX Slimlux, the slender, ceiling-hugging luminaire with sparkling crystal Prismoid sides and bottom. Complete range of sizes.

2615 Washington Blvd., St. Louis 3, Mo.